HUGO GERNSBACK, Editor

RADIO CRAFT

AND POPULAR ELECTRONICS ▼

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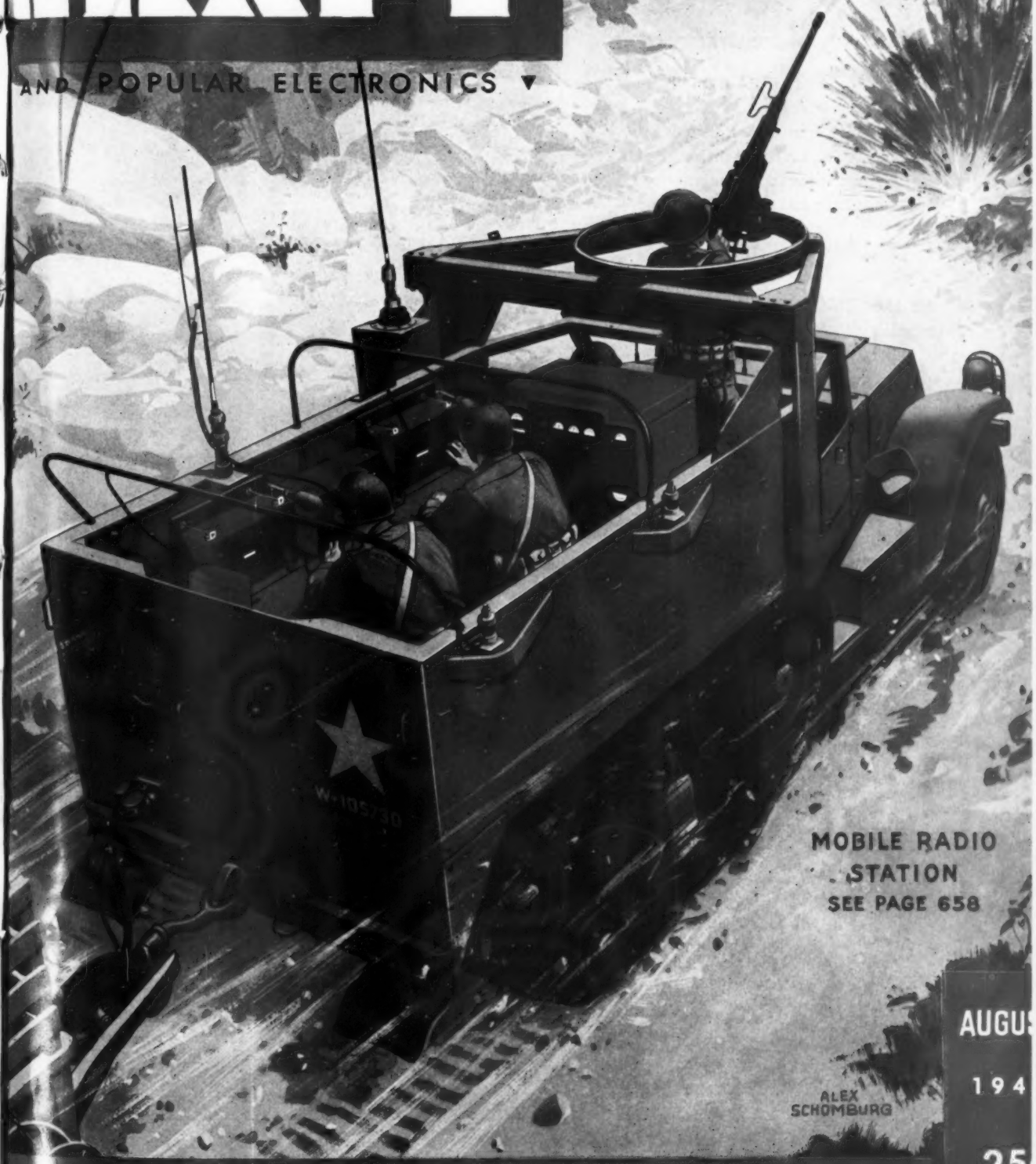


MOBILE RADIO STATION
SEE PAGE 658

ALEX SCHOMBURG

AUGUS
194
25
CANADA

ADIO-ELECTRONICS IN ALL ITS PHASES

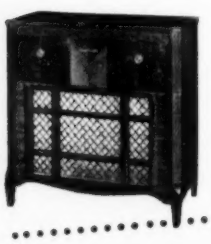
Handie-Talkie signals the attack!

HANDIE-TALKIE IS ANOTHER MOTOROLA RADIO *FIRST!*

If there is glory at all in war, *all of it* goes without question to the men who do the fighting. We who on the production front turn out the weapons for Victory find ample satisfaction in the knowledge that our product *delivers* when needed.

The Handie-Talkie is a battery powered radio receiver and transmitter no larger than a cracker box. The operator talks, giving information, and listens, receiving instructions. Officers and men in the infantry call it the "fightingest" radio set in the army! The "Handie-Talkie" was pioneered and developed exclusively by Motorola Electronics Engineers. It is a Motorola habit to be first!

GALVIN MFG. CORPORATION
CHICAGO 51, ILLINOIS



Motorola Engineers who were famous in peacetime for radio that delivered *peak performance will have pleasant surprises for you in Motorola Post-War Radio for Home and Car.*

Motorola Radio

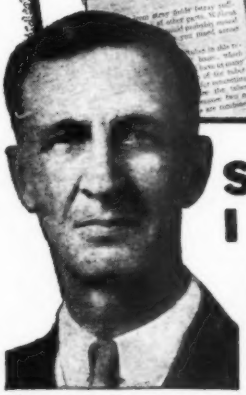
F-M RADIO ★ PHONOGRAPHS ★ RADAR ★ TELEVISION ★ F-M POLICE RADIO ★ MILITARY RADIO COMMUNICATIONS

Get this FREE Lesson in Radio

Gives you a real start toward understanding these subjects

With 31 Photos, Sketches, Radio Drawings

How superheterodyne circuits work
How to remove tubes, tube shields
Three reasons why Radio tubes fail
Electrodynamic loudspeaker:
  How it works
  Replacing damaged cone
  Recentering voice coil
  Remedies for open field coil
Output transformer construction, repair
Gang Tuning condenser:
  Construction of rotor, stator
  How capacity varies
  Restringing dial cord
  Straightening bent rotor plates
I.F. transformers:
  What they do, repair hints
How to locate defective soldered joints
Inside story of carbon resistors
Paper, electrolytic, mica, trimmer condensers
How condensers become shorted, leaky
Antenna, oscillator coil facts
Power transformer:
  Construction, possible troubles
Installing power cord
Troubles of combination volume control, on-off switch
Tone controls
Dial lamp connections
Receiver servicing technique:
  Checking performance
  Testing tubes
  Circuit disturbance test
  Isolating defective stage
  Locating defective part



See For Yourself How I Train You at Home to BE A RADIO TECHNICIAN

I want to give every man who's interested in Radio, either professionally or as a hobby, a copy of my Lesson, "Getting Acquainted With Receiver Servicing"—absolutely FREE! It's a valuable lesson. Study it—keep it—*use* it—without obligation! And with it I'll send my 64-page, illustrated book, "Win Rich Rewards in Radio," FREE. It describes many fascinating jobs in Radio, tells how N.R.I. trains you at home in spare time, how you get practical experience with SIX KITS OF RADIO PARTS I send.

This "sample" Lesson will show you why the easy-to-grasp lessons of the N.R.I. Course have paved the way to good pay for hundreds of other men. I will send it to you without obligation. MAIL THE COUPON!

Big Demand Now For Well-Trained Radio Technicians, Operators

Today there's a shortage of capable Radio Technicians and Operators. Fixing Radios pays better now than for years. With new Radios out of production, fixing old sets, which were formerly traded in, adds greatly to the number of servicing jobs. Broadcasting Stations, Aviation and Police Radio, and other Radio branches are searching for Operators and Technicians. Radio Manufacturers employ many trained men. And think of the NEW jobs that Television, Electronics, and Frequency Modulation will open up after the war!

Many Beginners Soon Make $5, $10 a Week EXTRA in Spare Time

As soon as you enroll for my Course I start sending you EXTRA MONEY JOB SHEETS that help show you how to earn $5 to $10 a week EXTRA in spare time while still learning.

Mail Coupon for Free Lesson and Book

The opportunity the war has given beginners to get started in Radio may never be repeated. So take the first step at once. Get my FREE Les-on and 64-page, illustrated book. No obligation. Just mail coupon in an envelope or paste it on a penny postal.—J. E. SMITH, President, Dept. 4HX, National Radio Institute, Washington 9, D. C.

OUR 30TH YEAR OF TRAINING MEN FOR SUCCESS IN RADIO

I Trained These Men

$200 Month In Own Business "I am in business for myself making around $200 a month."—writes Arlie J. Froehner, 300 W. Texas Avenue, Goose Creek, Texas.

$5 to $10 Week In Spare Time "I am engaged in spare time Radio work. I average from $5 to $10 a week extra from this work."—T. K. Dubree, Horsham, Pa.

Communication Station Operator "Am with Civil Aeronautics Administration at Shreveport Airways Communication station. Have a lifetime position with pension after retirement."—Jesse Roberts, Box 1076, Shreveport, La.

Chief Operator Broadcasting Station "Before I completed your lessons, I obtained my Radio Operator's license and joined Station WMPC where I am now Chief Operator."—Hollis F. Hayes, 327 Madison St., Lapeer, Michigan.

My Radio Course Includes
TELEVISION • ELECTRONICS
FREQUENCY MODULATION

You Build These and Many Other Radio Circuits with 6 Kits of Parts I Supply

By the time you've conducted 60 sets of Experiments, made hundreds of measurements and adjustments, you'll have valuable PRACTICAL Radio experience.

You build MEASURING INSTRUMENT above early in Course, useful for Radio work to pick up EXTRA spare time money. It is a vacuum tube multimeter, measures A.C., D.C., R.F. volts, D.C. currents, resistance, receiver output.

You build the SUPERHETERODYNE CIRCUIT above containing a preselector oscillator-mixer-first detector, i.f. stage, diode-detector-a.v.c. stage and audio stage. It will bring in local and distant stations. Get the thrill of learning at home evenings in spare time while you put the set through fascinating tests!

Building the A. M. SIGNAL GENERATOR at right will give you valuable experience. Provides amplitude-modulated signals for test and experimental purposes.

GOOD FOR BOTH 64 PAGE BOOK SAMPLE LESSON FREE

Mr. J. E. Smith, President, Dept. 4HX
NATIONAL RADIO INSTITUTE, Washington 9, D. C.

Mail me FREE, without obligation, Sample Lesson and 64-page book, "Win Rich Rewards in Radio." (No salesman will call. Please write plainly.)

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Name .....

Address .....

City ..... State 4FR

RADIO CRAFT
AND POPULAR ELECTRONICS

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IN THE NEXT ISSUE

The Ghosts of Television
Broadcasting Equipment
The Electron Microscope
A Dynamic Tube Tester
An Electronic Voltmeter

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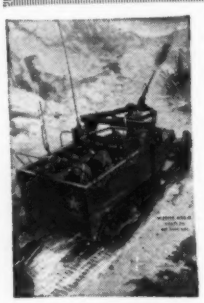


ON THE COVER

The Army's efficient mobile radio station, the SCR-299, is illustrated on our cover this month. Equipped with a 450-watt transmitter and a pair of receivers, it transmits and receives while travelling at full speed. The power supply is carried behind on a trailer. The SCR-299 may also be dismounted and worked as a fixed station.

THE FOURTH REASON....

The men and women of Hallicrafters Company are proud to receive the Fourth Army-Navy Production Award. It is a Fourth Reason, a Fourth Incentive, to continue to produce the most and the best that those at the fighting fronts all over the world shall not have "too little, too late." With deep humility and with the realization that to produce is the least that can be done for those who fight, the people of Hallicrafters accept this award.

BUY A WAR BOND TODAY!

hallicrafters RADIO

THE HALLICRAFTERS COMPANY, CHICAGO 16, U. S. A.

THE FIRST EXCLUSIVE RADIO MANUFACTURER TO RECEIVE THE "E" AWARD FOR THE FOURTH CONSECUTIVE TIME

NEW LETTER CONTEST for SERVICEMEN!

ELEVEN 1st PRIZE WINNERS IN 5 MONTHS IN CONTEST No. 1!

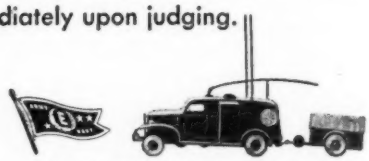
Yes sir, guys, the hundreds of letters received were so swell that *double* first prize winners had to be awarded each of the first four months and there were *triple* first prize winners the fifth and last month...

SO—HERE WE GO AGAIN!

Get in on this NEW letter contest—write and tell us your *first hand* experiences with *all* types of Radio Communications equipment built by Hallicrafters including the famous SCR-299!

RULES FOR THE CONTEST

Hallicrafters will give $100.00 for the best letter received during each of the five months of April, May, June, July and August. (Deadline: Received by midnight, the last day of each month.)... For every serious letter received Hallicrafters will send $1.00 so even if you do not win a big prize your time will not be in vain. ... Your letter will become the property of Hallicrafters and they will have the right to reproduce it in a Hallicrafters advertisement. Write as many letters as you wish. V-mail letters will do.... Military regulations prohibit the publication of winners' names and photos at present... monthly winners will be notified immediately upon judging.



BUY A WAR BOND TODAY!

hallicrafters RADIO

THE HALLICRAFTERS CO., MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPMENT, CHICAGO 16, U. S. A.

MAKE MORE MONEY IN Radio TELEVISION & ELECTRONICS

Now! GET THESE 3 BOOKS FREE!

You men already in radio know how great the demand is for **trained, experienced service men,** operators and technicians. You know how fast the field is growing and how important it is to keep up with developments—FM receivers, television, electronics.

Or even if you are merely INTERESTED in radio as an amateur, you must recognize the WONDERFUL OPPORTUNITY right within your grasp to **cash in on your natural talent.** Make it pay dividends. Get into the EXPERT RADIO SERVICE Line. Be a TELEVISION specialist—OWN A BUSINESS OF YOUR OWN. Fill out and mail the coupon below for all the details.

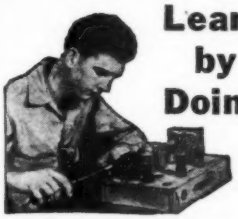
1. A complete catalog describing the industry and the extensive training facilities of National Schools.

2. You receive a sample lesson illustrating the modern "Shop Method" instruction technique.

3. The vast opportunity field of Electronics, "The Dawn of a New World," is revealed in this fully illustrated book recently published.

Get the Latest Inside Information—Trade Secrets by

SHOP-METHOD HOME TRAINING

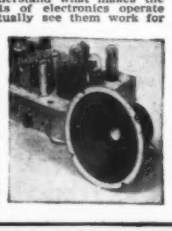


Learn by Doing

Use Actual Radio Equipment Furnished With Your Course

Experience is the best teacher. You learn by experience with the exclusive National Shop-Method of Home Training—actually build many circuits and do experiments with the big kits of standard radio parts included in your training **equipment at no extra cost** to you.

In the course of your study you actually build various types of receivers—a powerful superheterodyne, a signal generator, an audio oscillator and others . . . You make tests and conduct experiments that **show you the why and how of things.** You understand what makes the various elements of electronics operate because you actually see them work for you. Not only do you gain marvelous actual experience by this method of learning but you have valuable equipment you will use on the job in the practice of your profession as an electronics expert. Mail the coupon and learn what this means to you.



Now the famous National Schools brings its exclusive Shop-Method of training right in your own home. You can learn the most up-to-date, approved projects, systems and hook-ups step by step **in your spare time.** This is the sound, practical training you want and need—the development of experienced instructors working with thousands of students right in the shops and experimental laboratories of National Schools—**one of the most advanced trade educational centers of the world.**

This is the MODERN SYSTEM OF TRAINING. It matches the rapid progress constantly being made in radio, television and electronics. It is TIME TESTED too. National Schools has been training men for more than a third of a century. **In essence this is the very same training that has helped thousands to more pay and greater opportunity.**

You owe it to yourself—your future—to read the book "Radionics"—FREE to you when you send in the coupon.

National Trained Men Now Making the Best Money in History

The real value of National Training shows up in the quick progress our men make on the job. Joe Grumich of Lake Hiawatha, N. J., turned down a job most men would welcome. He writes: "My latest offer was $5,800.00 as radio photo engineer, but I am doing well where I am now engaged. I am deeply indebted to National."

Ely Bergman, now on Station WOR, told us: "My salary has been boosted considerably and at the present time I am making over $3,000.00 per year, thanks to National Training." And from the far-off Hawaiian Islands, Wallace Choi sends this: "I am averaging $325.00 a month. I will say that I honestly owe all this to the excellent training I had at National."

National is proud of the progress graduates are making all over the world. Read about their records yourself in the books we send you FREE.

Make Extra Money Right from the Start

You get ahead fast with National Training. **Many beginners make good money** on the side fixing radios and doing service work. You can turn your knowledge into cash after the first few lessons. Progress is rapid. You can actually SEE YOURSELF GET AHEAD, because the National Shop Method is so sound and practical.

Now, right now, is the time to grasp the **opportunity of today— a successful career for tomorrow.** Get into the big money, rapid advancement, a position of importance. A BUSINESS OF YOUR OWN. **Radio, television** and the whole field of electronics invites you. The industry is crying for trained men everywhere. A rapidly expanding industry — probably the greatest in history — holds out the promise of a **rich future**—prosperous security.

Train While You Are In Service

Prepare, right now, while you are in uniform, for a glorious secure future in the field of radio and television when the war is over. **Make good use of your spare time** by taking your National Training now. Men in our armed service, or about to enter, get better ratings and more pay almost right from the start if they are trained in radio, television and electronics. The government needs experienced men in nearly all branches of the service. Prepare for present advancement and a sound future. Learn how easy it is the National way. We are so enthusiastic because we have seen the marvelous results of National Shop Method Home Training. **Send in your coupon today** and see for yourself.

FREE LESSON INCLUDED

Examine the exclusive National Shop Method of Home Training. See for yourself how sound and practical it is. Be convinced that you **can learn radio — electronics, television** — quickly and easily in your spare time. You can't tell until you try. This trial is ABSOLUTELY FREE. And you may keep all the valuable material we send you without any obligation of any sort. Fill out the coupon immediately while you are thinking about it and drop it in the mail at once.

Thousands of men in the Army, Navy and Coast Guard have trained at National under U. S. Government sponsorship.

You are the man who must be satisfied.

Mail the coupon here for the three books that tell you the complete story of the marvelous new system of training in radio electronics and television. Learn the facts of this exclusive shop-method of home training. **See for yourself!** DECIDE FOR YOURSELF! No salesman from National Schools will call on you.

NATIONAL SCHOOLS

LOS ANGELES 37, CALIFORNIA EST. 1905

MAIL OPPORTUNITY COUPON FOR QUICK ACTION

National Schools, Dept. 8-RCR
4000 South Figueroa Street, Los Angeles 37, California

(Mail in envelope or paste on penny post card)

Mail me FREE the three books mentioned in your ad including a sample lesson of your course. I understand no salesman will call on me.

NAME ..... AGE.....

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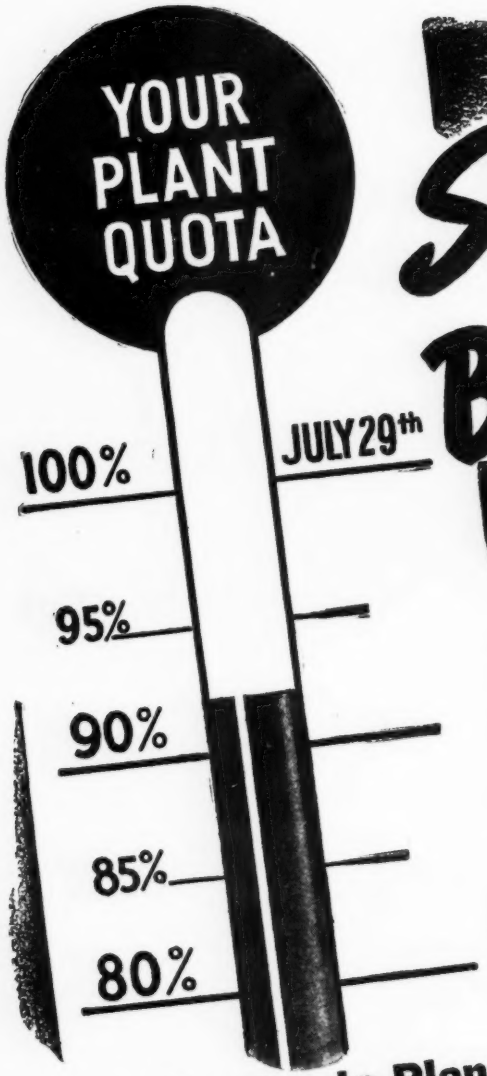
CITY ..... STATE .....
Include your zone number



Stay at Your Battle Stations!

MANAGEMENT
LABOR

—the 5th War Loan Drive is still on.

July 29th is the last pay day in the Drive.

The U. S. Treasury has set the overall goal at $16,000,000,000 —$6,000,000,000 from individuals alone. This is the biggest sum ever asked of the American people—*and it must be raised!*

Keep fighting. The 5th War Loan is a crucial home front battle of tremendous importance to the total war effort.

Tighten up your 5th War Loan Drive organization. Step up your solicitation tempo. Drive! Drive!! Drive!!! Hit your Plant Quota's 100% mark with a bang that'll proclaim to all the world that the U. S. Home Front is solidly in back of the Fighting Front.

Need help? Need ideas? Call on the Chairman of your War Finance Committee. He's standing by.

Here's the Quota Plan:

1. Plant quotas are to be established on the basis of an *average* $100 *cash* (not maturity value) purchase per employee.
2. Regular Payroll Savings deductions made during the drive accounting period will be credited toward the plant quota.
3. Employees are expected to contribute toward raising the cash quota by buying extra 5th War Loan Bonds: 1—Outright by cash. 2—By extra installment deductions. 3—By extra installment deductions plus cash.

Example: JOHN DOE MFG. CO.—1,000 Employees

1,000 Employees x $100 . . . $100,000 Cash Quota

Regular payroll deductions during the eight weekly payroll accounting periods of June and July. — 30,000

$70,000 (to be raised by sales of extra Bonds).

BACK THE ATTACK—SELL MORE THAN BEFORE

The Treasury Department acknowledges with appreciation the publication of this message by

RADIO-CRAFT

★ *This is an official U. S. Treasury advertisement—prepared under the auspices of Treasury Department and War Advertising Council* ★

PICTURE PAGE of Mt. Carmel's Famed Precision-el

Ever hear the story of how "precision-el" originated? It was coined by a writer who visited the Meissner plant at Mt. Carmel some time ago. He had watched in amazement as hundreds of flying fingers handled intricate and delicate assignments with unerring precision. "This," he was told, "is just a small part of Meissner's personnel . . . "

"Personnel?" he exclaimed. "Well, from what I've seen today, I'd call them 'precision-el'! No wonder Meissner has such a reputation for quality!"

Time Out! This busy worker pauses for only a fleeting second as the roving photographer snaps his picture. He does his part in making the vital and highly technical products with which Meissner supplies Allied armed forces 'round the world.

Precision-el at Work! These young women, like many Mt. Carmel residents, have literally learned the electronic business "from the ground up." They are versatile enough to handle any one of many difficult assignments.

Specialist! Mt. Carmel, Illinois, is said to have more electronic technicians per thousand population than any other city in America. This young lady is one of many experienced workers at Meissner's Mt. Carmel plant.

Veteran! Here is another reason for Meissner's top reputation for precision work. Meissner people rightly take pride in their job, in their own personal production.

Now! Special 1944 Bulletin

Here's what everyone in the industry needs to know about Meissner's 1944 line of radio parts. Contains complete descriptive matter, with pictures. Now, more than ever, it pays to keep posted on what Meissner offers. Send for your copy today, because the supply is limited. Free! Write to address below.

MEISSNER

MANUFACTURING COMPANY • MT. CARMEL, ILL.

ADVANCED ELECTRONIC RESEARCH AND MANUFACTURE

Science on the Production Line

Commonly you think of the microscope as a scientific laboratory instrument. But at National Union, these days, you will find it even more extensively used, as a *production* machine, insuring microscopic precision step by step through many processes of manufacture.

With the aid of microscopes, National Union workers accurately check almost invisibly small parts. They *see* to it that welds are sound, clearances are exact and the structure is mechanically perfect. In the photograph above for example, a N. U. 6AG5 miniature tube mount, no higher than your thumb nail is enlarged approximately 10 times, to permit minute examination of important structural factors. Enlargements up to 500 times—making a hair on your head look as tall as a tree—are just as readily obtained, when needed. Moreover, this tube, assembled from 31 individual parts, must pass 40 individual inspections, in addition to thorough examination under the microscope.

The advanced scientific production techniques developed by National Union engineers are helping to raise tube performance standards and lengthen tube life. To service engineers with an eye to the future, they assure the superior post-war values that will win loyal friends and build profitable business. *Count on* National Union.

NATIONAL UNION RADIO CORPORATION, NEWARK, N. J.
Factories: Newark and Maplewood, N. J.; Lansdale and Robesonia, Pa.

NATIONAL UNION
RADIO AND ELECTRONIC TUBES
Transmitting, Cathode Ray, Receiving, Special Purpose Tubes • Condensers • Volume Controls • Photo Electric Cells • Panel Lamps • Flashlight Bulbs

Remote Control Weapons

. . . . The present war has introduced the first remote-controlled weapon. The future will bring a far greater variety of more formidable and more powerful war machines. . . .

HUGO GERNSBACK

THE so-called secret Nazi weapon—which was not a secret at all—first appeared on a fairly large scale against the British Isles last June.

As long ago as last February, Prime Minister Churchill several times mentioned the fact that the Germans were going to launch their "secret weapons" against English cities.

The Nazis subsequently made good their threats. By means of their pilotless robot planes, carrying a high explosive and weighing about a ton, they indiscriminately sprayed the English countryside with these flying robot-bombs.

The type which was used during June was not radio-controlled. The planes were launched from secret roller-coaster chutes, then winged their way over the English Channel and plummeted down haphazardly over town and country in southern England. These particular Nazi rocket-propelled robot planes were steadied in their flight by a regulation gyro compass, but the Germans at the sending end had no idea where the missiles would finally land. This was wholly beyond their control because the robot planes could not change their course once they were launched. Wind drift, atmospheric conditions, squalls, etc., naturally affected the course of the robots considerably, so that all they accomplished was a slight degree of terror. From a military viewpoint the Naxi aerial robots were complete duds as they could not be sent or directed to a specific target. They demolished houses, killed people, and in general raised some havoc, but even the Nazis had to admit that their robot-bombs would have no effect upon the outcome of the war.

This is the first time in warfare that a major effort was made by any power to use long-distance robot missiles against an enemy. It is true that there is a parallel with the German "Big Bertha" supergun, during the first World War, which bombarded Paris from a distance of not quite eighty miles. This was orthodox artillery where the shell exploded and killed people indiscriminately, similar to what the robot planes did in England last June. But the Paris gun projectile weighed only a fraction of the new robot bomb, consequently the latter could do far more damage than the former.

So far the Allied countries have viewed the German effort with disdain and scorn, chiefly for the reason that it is not a military weapon and because the enemy cannot see and know in advance where the missiles will strike. Allied military men look upon the Nazi robot plane as a tacit admission that the German *Luftwaffe* has failed miserably, and further that the weapon was used primarily as an instrument of revenge in order to raise German morale.

It is certain that military science will not stop with the Nazi robot plane. It is only the forerunner and the first example of far more effective and frightful weapons to come.

Long distance rocket-bombs which are radio-controlled and can be aimed fairly accurately are no longer an impossibility. I referred to them in an article in the last issue of RADIO-CRAFT. But even more effective long distance robot weapons are in the offing.

As long ago as 1924—to be exact, in my former publication THE EXPERIMENTER Magazine, November 1924 issue, I was the first to describe in word and picture a pilotless robot plane, which was television-controlled. Here we have a weapon which—contrary to the Nazi terrorizing robot—can be conveyed over hundreds of miles to the exact spot desired, without any human being aboard the machine. The television-controlled airplane sees in six directions at the same instant—something no human being can accomplish. The television plane, as I described it twenty years ago, has six photo-electric eyes which can see north, south, east and west, up and down simultaneously. A continuous image of what the plane *(Continued on page 693)*

Radio Thirty-Five Years Ago

In Gernsback Publications

FROM the August, 1909, issue of MODERN ELECTRICS:

This was the first special wireless number of this or any other magazine.

The Nauen Wireless Plant (Complete story of the famous German plant located near Berlin with illustrations.)

How to Make a Polarized Relay, by *H. W. Secor.*

Musical Wireless Receiver.

A New Type of Wireless Transformer, by *A. Press.*

Wireless Dirigible Torpedo (Account of first radio-controlled torpedo.)

The New Telefunken System, by the Berlin Correspondent.

HUGO GERNSBACK
Founder

Modern Electrics	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Radio-Craft	1929
Short-Wave Craft	1930
Wireless Association of America	1908

Airship Run By Wireless.

Paris-America Wireless Accomplished.

Wireless Waves Can Be Seen (First account of Paris scientist, M. Abraham, who projected a wave form onto a screen).

Some of the larger libraries in the country still have copies of Modern Electrics on file for interested readers.

Method of Testing Short Circuited Condensers, by *I. Wolff.*

A Novel Detector, by *D. C. Spooner.*

Wireless Lightning Protector.

New Type of Loud-Speaking Telephone.

Detector Construction by *L. Spangenberg.*

New French Wireless Apparatus, by *A. C. Marlowe.*

The Construction of a Loop Antenna Relay, by *A. C. Austin, Jr.*

A Variable Condenser, by *L. W. Teller.*

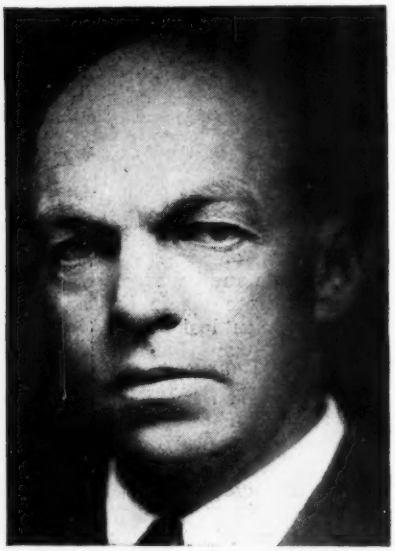
Attachment for Wireless Key, by *Eric M. Luster.*

A Conductive Wireless System, by *E. E. Gourley.*

Radio-Electronics

Items Interesting

MAJOR ARMSTRONG, outstanding pioneer, was last month awarded a Certificate of Appreciation by the Signal Corps in recognition of the valuable work he is now doing for the United States. Definitely, the citation was for "outstanding contributions to the Signal Corps, Army Service Forces." Armstrong was further honored in that the certificate to him was the first one of its kind to be issued.



© *Bachrach*

The Signal Corps appreciates Major Armstrong.

It is the intention of the Signal Corps to present such certificates to individuals and companies who have performed notable services beyond the normal requirements of duty but who are not under the direct control of the War Department and are therefore not eligible for the Army-Navy "E."

Several other certificates have already been awarded to individuals and companies. Possibly the most notable figure to receive one is Dr. Harold H. Beverage, old-time radio researcher and inventor, now an associate director of the RCA Laboratories.

Dr. Armstrong's contributions to this war began in 1941, when he waived all his royalties on the use of 17 patents covering FM apparatus used by the War Department. At the same time he offered to license any manufacturers designated by the War Department to produce apparatus under his patents for use during the present emergency, at the rate of one dollar a year per patent.

This is not the first time Dr. Armstrong's efforts have been of value to the War Department and the radio public. It was as a Signal Corps officer in France during the last war that he developed the superheterodyne circuit, now used in practically all broadcast receivers. Later he originated the super-regenerator, commonly used in ultra-short-wave reception, and as a crowning triumph, brought out (in 1934) his latest invention, FM, which has already revolutionized standards of broadcast reception.

●

LITIGATION may delay the post-war development of television, believes Cecil B. DeMille, pioneer motion picture producer.

In an interview last month, he recalled the early legal skirmishes over moving picture patents and forecast that television might have to go through the same struggle.

MEXICO prefers radios of U. S. manufacture, according to a report last month by Theodore H. Meyer of the United States Embassy in Mexico City.

The American brands, which already represented nearly 90% of all imported in 1939, had risen to practically 100% in 1941, in which year 123,580 receivers were brought in from the United States out of a total importation of 123,639.

Public acceptance by the Mexican market is based on: (1) selectivity, (2) tone quality, (3) ability to obtain distance, and (4) stability on short-wave. If manufacturers in the post-war period were to incorporate in their circuit features high sensitivity, a high fidelity audio-system, an improved signal-to-noise ratio, and an automatic volume control of improved design that would keep short-wave, long-distance signals at uniform level a tremendous demand in this market for new receivers would result, Meyer reported.

●

AN ELECTRONIC Paul Revere rode again in the early hours of D-Day, in the person of George Hickenbaugh, chief engineer of Radio WMT. Hickenbaugh had long prepared for the moment, and when the news of invasion was confirmed in the early morning hours, he was ready to spring to the seat of his waiting sound truck, throw in the clutch and turn up the volume.

The truck covered all the main residential areas of Cedar Rapids, Iowa, with a call loud enough to bring the citizens out of their beds. Ever mindful of the advertising value of his work, the new Paul Revere notified his hearers that the big news was being broadcast over WMT and urged them to tune in.

Underwood & Underwood Studios

Dr. Harold Beverage, recipient of Army honors.

RUMORS of early civilian radio receiver production were disposed of by the *War Production Board* in a statement last month.

Contrary to published reports, says the Radio and Radar Division of the WPB, no authorization for the production of any new radio receiving sets has been issued, nor is there any prospect of such authorization this year.

Production of radio receiving sets for civilians has been prohibited by the WPB since April, 1942. The military electronics equipment program for 1944 is approximately 50 per cent above 1943 production, so the prospect of resumption of civilian radio set production is remote.

Assembly of a limited number of radio receiving sets by manufacturers for military users for morale purposes, such as overseas recreation centers and hospitals, has been authorized, the division said. Such authorization may have given rise to reports of resumption of civilian production.

No steps in the direction of authorized production of civilian radio sets would be taken without first consulting the radio industry through the WPB Industry Advisory Committees, the Radio and Radar Division pointed out.

●

NETWORK regulations, protested in some quarters as the first step toward the destruction of the broadcast industry, have been compatible with a noteworthy improvement in the commercial status of broadcasting. So stated F.C.C. Chairman James Lawrence Fly on the occasion of the first anniversary of network rules:

"Thursday, June 15, marks the first anniversary of radio's Emancipation Day. On June 15, 1943, the F.C.C. Chain Broadcasting Regulations, as upheld by the U. S. Supreme Court, went into effect; and I am glad to say that never before in its history has the industry been so prosperous.

"Despite predictions of doom by network officials if the regulations became effective, broadcasting profits are higher now than ever before. Broadcasting stations as a whole earned 50 per cent more, before income taxes, in 1943 than in 1942, and the networks similarly profited. Thus NBC, which in 1942 earned 137 per cent on the value of its property, in 1943 earned a return, before income tax of 190 per cent. CBS went up from a 97 per cent return in 1942 to a 158 per cent return in 1943. The Blue Network went up from 8 per cent to 149 per cent, and the stockholders in the Mutual Network, on a combined basis, earned a return of 84 per cent in 1943 as against 59 per cent in 1942. Experience has now shown that the prophets of disaster were mistaken, and that the broadcasting industry can prosper as never before under our regulations."

The commission is now studying program logs of all broadcasting stations to determine the extent to which the Chain Broadcasting Regulations have resulted in increased availability of network programs to listeners.

Monthly Review
to the Technician

A BATTLE for supremacy in post-war television was envisioned by James D. Shouse, general manager of Radio WLW, Cincinnati, in an address to the Television seminar of the Radio Executives' Club in New York last month.

The present broadcasting industry, the moving picture interests, and the newspapers of the country may, Mr. Shouse believes, engage in a three-way battle for top position in the field, with the set manufacturers (and presumably the prospective users of television sets) sitting on the sidelines, and with the whole struggle finally being referred to the F.C.C. for settlement.

Mr. Shouse, after making it clear that he was expressing a personal opinion, stated that he felt that television will develop much more rapidly than has been expected. The present controversy is between members of the broadcast industry almost exclusively, yet the broadcasters may not have the power of ultimate determination in the case of television. The receiving set manufacturers represent a tremendously important power to either accelerate or slow down public demand or acceptance. The set manufacturer will have a great deal to say as to how rapidly or how slowly home television equipment is introduced.

The WLW official also expressed surprise at the amount of attention FM was receiving as compared to television. "Television," he said, "does not represent a new way of doing the same thing that has been done before. It adds an increment and a dimension that is constructive and creative. It does not supplant a coupe with a sedan."

●

CYCLOTRONS, now used to accelerate ions to speeds practically impossible to attain otherwise without the use of millions of volts, may now be operated in reverse, if the suggestion made last month by Dr. Laurence E. Dodd of the University of California is accepted.

In a scientific paper presented before the American Physical Society, Dr. Dodd maintained that it is theoretically possible to reverse the usual cyclotron procedure in such a way as to catch rapidly traveling particles such as cosmic rays and slow them down for study and experiment.

The cyclotron imparts tremendous speeds to particles by whirling them in an ever-increasing spiral between two electrodes which alternate their charges at high frequency, Dr. Dodd pointed out. But even at its fastest the cyclotron does not yet project particles with the speed of cosmic rays, and some method of producing higher frequencies would have to be found before the cyclotron could act as a "catcher" for such rays.

Used in reverse, the cyclotron would present a field which would slightly retard the captured ray twice in each revolution as it spiralled inward toward what would be the "collector" in such an apparatus.

The Cyclotron is a child of the University of California, having been developed in its radiation laboratory by Professor Ernest O. Lawrence.

CHANGES in the U. S. Standard Frequency Service were announced by the Bureau of Standards last month.

At least three radio carrier frequencies are now on the air at all times, to insure reliable coverage of the United States and other parts of the world. The radio frequencies are:

2.5 megacycles per second, broadcast from 7:00 P.M. to 9:00 A.M., EWT (2300 to 1300 GMT).

5 megacycles per second, broadcast continuously day and night.

10 megacycles per second, broadcast continuously day and night.

15 megacycles per second, broadcast from 7:00 A.M. to 7:00 P.M., EWT (1100 to 2300 GMT).

Two standard audio frequencies, 440 cycles per second and 4000 cycles per second, are broadcast on the radio carrier frequencies. Both are broadcast continuously on 10 and 15 megacycles. Both are on the 5 megacycle transmission in the daytime, but only the 440 is on 5 megacycles from 7:00 P.M. to 7:00 A.M., EWT. Only the 440 is on 2.5 megacycles.

The 440 cycles per second is the standard musical pitch, A above middle C; the 4000 cycles per second is a useful standard audio frequency for laboratory measurements.

In addition there is, on all carrier frequencies, a pulse of 0.005-second duration which occurs at intervals of precisely one second. The pulse consists of five cycles, each of 0.001-second duration, and is heard as a faint tick when listening to the broadcast; it may be used as an accurate time signal. On the 59th second of every minute the pulse is omitted.

The audio frequencies are interrupted precisely on the hour and each five minutes thereafter; after an interval of precisely one minute they are resumed. This one-minute interval is provided in order to give the station announcement and to afford an interval for the checking of radio-frequency measurements free from the presence of the audio frequencies. The announcement is the station call letters (WWV) in telegraphic code (dots and dashes), except at the hour and half hour when an announcement is given by voice.

●

TINFOIL strips, long used by airmen on both sides to foil plane-locating apparatus, are being employed in a new manner by the Germans.

Formerly these strips were dropped from planes, filling the air with strips of metal which apparently confuse operators of ranging devices. The new Nazi "weapon" used on the invasion front in France works in the opposite direction. A box about a foot square is shot to a height of 6,000 to 8,000 feet. It then bursts open and releases a bunch of long, silvery and apparently metallic strips.

It seems obvious that these are intended as a defense measure against the undisclosed Allied radio devices which permit precision bombing through clouds and fog. Some airmen have expressed the belief that probably the strips were merely intended to foul the propellors of attacking airplanes. This is to be doubted however.

OBSERVATIONS on a phenomenon in radio propagation hitherto not reported—long-distance bursts causing interference in the very high frequency band which includes the band 42-50 megacycles now assigned to FM broadcasting—were announced last month by the Federal Communications Commission.

The amplitudes of the bursts, according to F.C.C. engineers, have varied from the lowest levels which can be measured up to levels well in excess of that required to render a satisfactory FM broadcast service. During periods of maximum activity they may occur at the rate of several hundred per hour. However, the amplitudes of but few of the bursts are sufficient to cause serious interference to a receiver operating within the protected area of an FM station under present F.C.C. standards.

A 2-way General Electric FM transmitting antenna.

A "burst" is defined as a sharp increase of signal strength of very short duration—seldom covering more than the time consumed by a single spoken word or a note or two of music—from an FM station located at a considerable distance from the observer. Since February, 1943, F.C.C. engineers have been recording reception from certain FM stations to determine the nature and extent of the interference.

The bursts were observed from the higher powered FM stations only. This may account for the failure of amateurs, experimenters and others to have reported this type of interference in this frequency range. The bursts are not normally observed from nearby FM stations, since the steady ground wave signal is of sufficient strength to obscure them, but they may be observed in such instances by a system of pulsing or by a directional antenna which discriminates against the ground wave. At greater distances where the steady signal is absent or of low intensity, the bursts may be heard through the loud-speaker or may be recorded by a suitable recorder.

Bursts have been observed by both methods at distances up to 1400 miles from certain FM stations, but are neither so intense nor so numerous at the longer distances as they are at distances of 300 to 700 miles. Commission engineers observed a systematic variation in the relative numbers of bursts which occur from hour to

(Continued on page 685)

PHANTOM SOUNDS

By WAYNE BARLOW

IT has been suggested in some quarters (see *Radio-Craft* for February, 1943) that the problem of re-creating a satisfactory illusion of reality in reproduced music, a problem essentially one of adequate frequency response and fidelity, be approached on the basis of extending the frequency spectrum at both ends by strengthening the subjective tones that form a part of normal auditory phenomena. It is the purpose of this article to examine the proposal and to point out certain fallacies in the proposed application of this method to radio broadcasting.

Briefly, a subjective tone is one that is perceived by the listener as a tone of a definite frequency; this frequency, however, is not present in the auditory stimulus that produces the illusion. The existence of such tones has been known to musicians and acousticians for two hundred years, yet their existence cannot be proven scientifically or otherwise analyzed. The most readily perceived subjective tones are those that are known collectively as *combination tones* and take the form of an illusion of a third frequency when two tones of different frequencies are heard. One such tone, the *difference tone*, will be heard as a frequency equal to the difference of the frequencies of the generating sounds; another, the *summation tone*, will be heard as a frequency equal to their sum. (Radiomen will realize that these "beats" are no illusion, and their existence is readily proved, for example by inserting a meter in the audio circuit and watching the periodic swing of the pointer.—*Editor.*)

A better example is the one that is perceived as the fundamental of a series of overtones. As an illustration of this type of tone, let us suppose that a complex wave form, such as might be generated by a musical instrument having a fundamental frequency of 220 c/s and upper partials of 440, 660, 880, 1100, and 1320, is fed into an audio amplifier. If a high-pass filter with a cut-off frequency of 300 cycles is introduced into the circuit, the ear will still hear the fundamental frequency even though it has been entirely suppressed. It will be noted that the difference in frequency between adjacent partials in every case is 220; therefore, it must be assumed that the perception of the fundamental is a function of the difference tone provided by one or more pairs of upper partials.

The practical aspect of this phenomenon is observed in the case of the ordinary telephone installation, in which the lower cut-off frequency is of the order of 300 cycles. The fundamental pitches of the speaking voices of men and women average roughly 128 and 256 cycles, respectively, yet these suppressed pitches are apparently heard. Likewise, reception on a midget radio receiver, where the low frequency response may be but little better than that of the telephone receiver, is such as to provide the illusion of a certain amount of bass.

So far as summation tones are concerned, there is little evidence that their contribution to the auditory experience is of any importance; the perception of such tones is difficult, even for a trained ear, and it can

(*Continued on page* 683)

The fantastic musical instruments illustrated here never existed, but distortion has brought them to us on many programs. The discriminating listener will recognize, reading from top down, the ACCORD-ORGAN, the GUITAHARP, the SOUSADRUM, the KETTLEVIOL and the CELLOSAX.

Photographs courtesy Pilot Radio Corporation

The above series of illustrations show how the destruction of overtones makes one instrument sound like another, or like a blend of two.

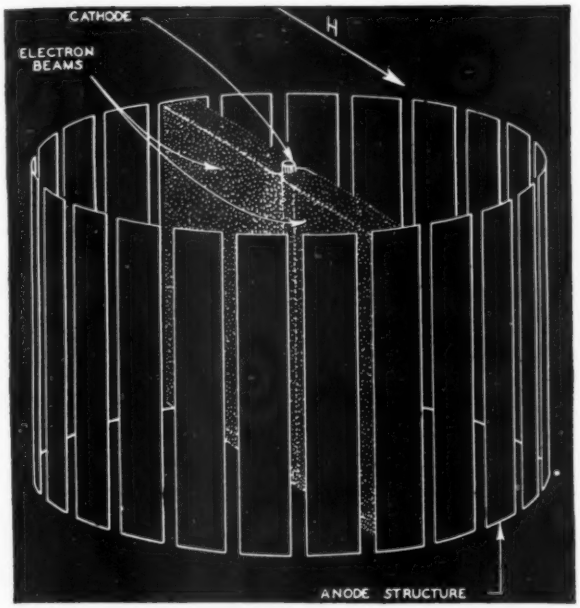
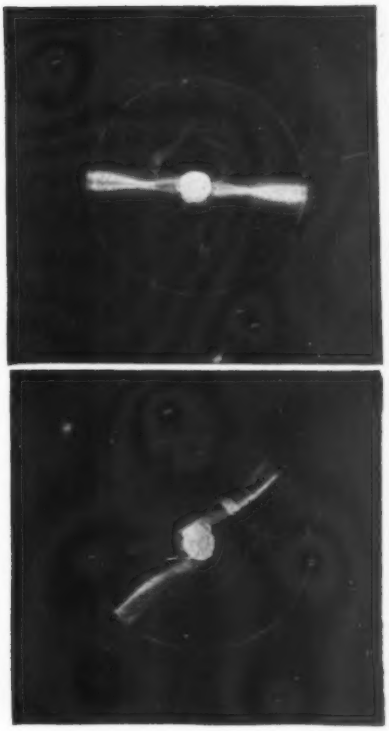


Fig. 1, left—Drawing shows the focussed beams. Rotation of these beams by a magnetic field is the tube's secret of operation.

Fig. 2, right—How the focussed beam looks. The electron paths were made luminescent by putting a small amount of gas into the tube.

All illustrations courtesy of Bell System Technical Journal



A Radial-Beam Tube

New Development is an Electronic Commutator

By I. QUEEN

AN entirely new type of tube with unusual possibilities has been developed and is already in operation in New York City, in a multiplex signalling system. This radial beam electron tube is remarkably simple in construction, requires no focussing arrangement, is small, works on low voltages and has high efficiency. It is used as an electronic commutator device and has recently been described in the *Bell System Technical Journal* by A. M. Skellett.

The cathode of this tube is held vertically and is surrounded by a cylindrical anode structure, as shown in Fig. 1. If each anode is at the same positive voltage with respect to the cathode, the anode current will, of course, be equally distributed among them, and each anode will receive approximately only 3% of the total cathode emission.

If a magnetic field (such as shown by the H arrow) is applied, the electron beam will be directed in only two diametrically opposite directions (Fig. 1), parallel to the applied magnetic field. If the uniform magnetic field were made to revolve, so would the two beams, so that such a field could serve not only for focussing but to provide rotation. In this application the two beams will contain approximately 90% of the cathode current!

The action of the beam is well shown in Fig. 2. For these photos the cathode was actively coated in only two opposite spots. Note how the electron beam twists in following the applied magnetic field.

A convenient rotating magnetic field is furnished by the stator of a two-pole polyphase A.C. motor. The tube is simply inserted into this stator in place of the usual armature. An unwound stator of this type is shown alongside an experimental tube in Fig. 3. The loss in a typical stator is under three watts, making the entire set-up highly efficient.

The tube in Fig. 3 is constructed with 30 anode elements. Each element is really a pentode tube, containing a control grid, screen, suppressor grid, along its path. Fig. 4 shows the construction. Note that only one beam is emitted, the other being suppressed.

Suppression of one of the beams is accomplished in several ways. At any instant the anodes on one side of the tube may be maintained positive and on the other side negative, this polarity rotating with the magnetic field. It may also be done by means of the suppressors. Still another method is to use an odd number of anode elements. Then when the beam falls on an element on one side it will fall between two elements on the other.

The maximum cyclic speed is approximately 10,000 per second. Since no mechanical wear results and no inertia is present, this tube makes an ideal rotating commutator.

An early system of multiplex telegraphy used a mechanical rotating commutator which switched in each communication channel for a small portion of the total time. This

(Continued on page 689)

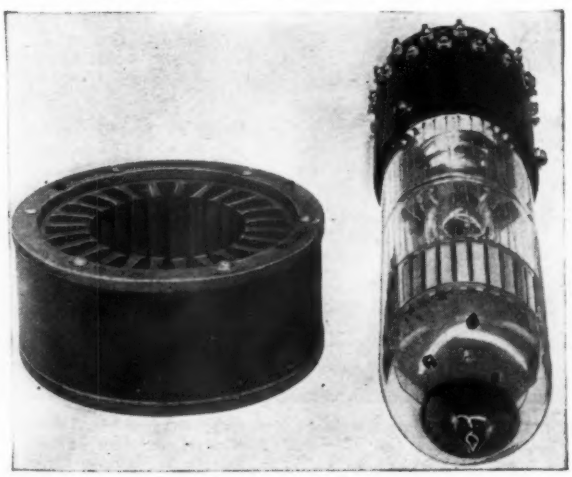
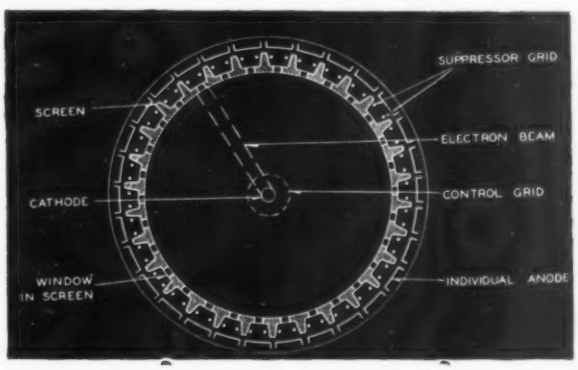


Fig. 3, left—The tube and its field magnet.

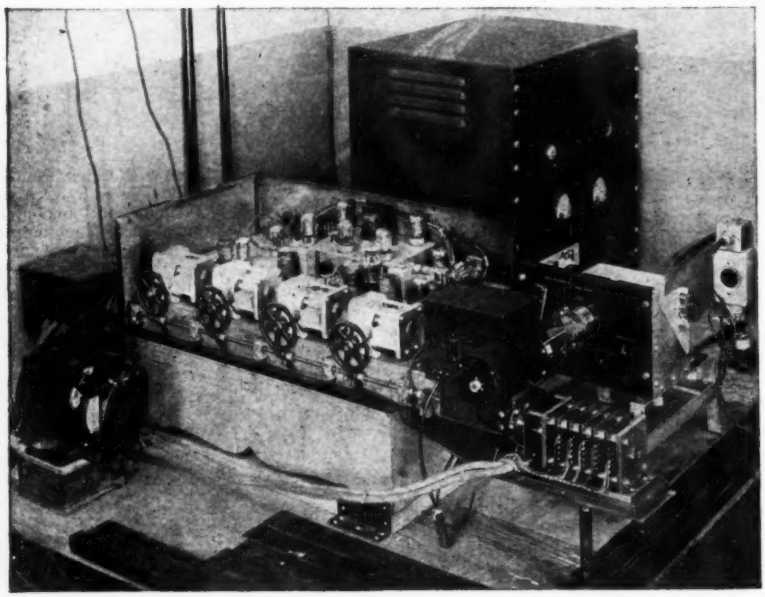
Fig. 4, right—Internal construction detail.



Electronic Brain Saves Time

AN electronic "Master Mind" is working for Victory at the Philco Corporation plant! This device can "think", calibrate, calculate and record many times faster than any human being, far more precisely, and all without danger of error.

An announcement from John Ballantyne, president of the corporation, revealed the development of this almost human "Master Mind". It employs 126 vacuum tubes and a multitude of intricate circuits and is used to calibrate Signal Corps frequency meters with uncanny accuracy. It has saved 144,000 man hours of labor and made it possible to reduce the cost of this type of equipment by $1,170,000 in 1943 alone.



Calibration of frequency meters was formerly done by hand. This was a painstaking, laborious process subject to human error. The task is to find the exact point of resonance or "zero beat" with a fundamental or harmonics of a standard frequency. Aside from the usual possible errors, the human ear is not sensitive at the very low frequencies so that it is difficult to judge an exact zero beat point.

After months of intensive research, Philco engineers completed the design and development of this special electronic instrument. It consists of three parts.

The first part supplies the source of standard frequencies against which calibration takes place. This standard is derived from WWV, the United States Government station in Washington, which in turn is calibrated from the movement of the heavenly bodies. This station is well known to experimenters and amateurs, who frequently make use of its service.

The second portion of the device provides a means of continuously driving the frequency meter dial while automatically generating a sharp pulse every time the frequency meter is turned through a zero beat with the standard signal. The third unit of the "Master Mind" automatically records and tabulates the dial reading corresponding to the zero beat.

For the purposes of this electronic "Master Mind" it was necessary to develop a special type of frequency modulation (FM) detector, because the problem of exact calibration is far more complex than ordinary broadcast detection. In this instance, a form of frequency modulation, highly involved as compared with ordinary broadcasting, has been put to work to perform a precision job.

This marvelous development has a job to do for the duration and holds promise of important post-war applications.—I.Q.

Navy's Salad Bowl

THE demand by the Navy for a loud-speaker that could rise to the occasion and satisfy the rigid requirements of today's great naval battles, has been met in a new speaker designed by Bell Telephone Laboratories and now being produced by the Western Electric Company. This high-powered unit, called the "salad bowl" because of its shape, has passed rigid Navy tests to insure reliable operation under the wide geographical range of the fleet's activities.

Designed for speech reproduction, this speaker has an outside diameter of 12½ inches and weighs approximately 25 pounds. The loud-speaker is constructed principally from former sheet steel and molded plastic.

The voice coil impedance of the unit is approximately 7.5 ohms. The speaker develops the high sound pressure of 50 dynes per square centimeter when operated at the rated electrical input and measured at 10 feet from the speaker on the sound axis in open air.

Other features of this loud-speaker are that it is resistant to shock, vibration, salt spray, gun blast, and is readily accessible for servicing, due to its simple construction.

English Radiowomen Are Aid to Invasion

Wirewomen of the British Royal Signals Corps are drawn from many walks of life. The two above, testing a tank set before installation, are Corporal Christina Harris, (left) a nursemaid before she entered the Armed Services of her country, and Private Joan Tipping, former salesgirl. Note the censored spots on the photograph, indicated by the arrows.

ELECTRONICS AND THE MOTOR CAR

By S. R. WINTERS

ACTING independently but toward the same broad purpose, the conservation of millions of automobiles and automobile tires, three inventors have designed, respectively an automatic electronic tire inspector; an electric-eye device to facilitate the parking of automobiles alongside curbs, without scraping our dwindling supply of rubber; and an electronic tester for auto headlights. The curb indicator is especially aimed toward assisting women drivers, whose parking problems are proverbial, in that the electric eye "sees" the automobile approaching the curb and warns, either visually or audibly, how close the driver is to the curbing.

The tire inspector reaches its greatest usefulness in tire inspection service during manpower shortage. This also is an automatic device, which exposes cuts, bruises, and embedded foreign material in tires, and then writes its own record of the concealed faults.

Electric eyes are employed in a device designed for the General Motors Corporation for testing automobile headlights, which eliminates the errors common to faulty human judgment.

STUDIES TIRE FAULTS

The electronic tire inspector, invented by William H. Capen of Mountain Lakes, New Jersey (patent rights assigned to the International Standard Electric Corporation of New York City), involves the use of a portable X-ray machine for focusing rays on punctured automobile tires and a photoelectric cell for exposing the exact spot of entry of nails or gravel into the ailing tire. The electric eye, somewhat like an electronic burglar alarm, rings a bell when the intrusive foreign objects which have penetrated the tire surface are brought before it.

When the rays from the portable X-ray apparatus penetrate the tire and strike a fluorescent screen the result is a radiograph, seen directly through a slit or tiny window. (See Fig. 1). The cell is connected to a radio amplifier and the necessary auxiliary controls for actuating an audible or visual indicator. The amplified radio signals are able to operate one or more of the following indicating devices: a bell, a recording tape, a warning light, a meter, and a brake for interrupting the rotation of the punctured tire. Inasmuch as the X-rays and the electronic unit are inclined to interfere with the appointed functions of each other, the fluorescent screen is applied to a sheet of lead glass. A shield, with a narrow slit in front of the lens, cuts down the field of vision of the photocell and at the same time magnifies the injured section of the tire. This small X-ray machine, with its companion electric eye, may be used in thousands of gasoline service stations with the conventional pit and hydraulic jack, thus expediting the periodically Government-required inspection of millions of automobile and truck tires.

ELECTRON-RAY PARKING AID

Versatile phototubes may save rubber other than by acting as simple inspectors of tires.

The electric-eye curb indicator, an invention of John Ray Toney of Los Angeles, California, by inference at least, was designed especially for women automobile drivers, whose error of judgment in accurately judging parking distance is traditional. A frequent sight on city streets is that of women, and men too, alighting from their automobiles to confirm their beliefs that th parking positions are awkward. Scraping of the rubber tires is inevitable. Mr. Toney proposes the installation of a series of photocells and their inseparable companions, lamps, on the front and rear fenders of automobiles. According to the inventor, the electric eye gauges the distance between the wheels and curbstone accurately, parking the vehicle almost automatically.

The photocells and auxiliary equipment are disguised in a suitable housing before being installed on the front and rear portions of a car. The ray of light from the lamphouse illuminates a tiny portion of the curbstone—the beam or pencil of light casting rays at an angle greater than zero and less than a straight angle. These pencil "marks" are indicated by arbitrary diverging lines, A and B (Fig. 2), and the light, energizing the photo-cell, is so narrowed down as to be included between another arbitrary set of lines, C and D. The outer lines, A and D, of the two diverging pencils of light intersect at E, pointing out the greatest distance from the automobile at which the curb is to be detected.

This invention is sufficiently flexible to admit of varying the size of the beam of light, the angle of divergence between the beams, A and B, and also the amount of light entering the photocell. The angular positions of the lamp-house, and the encased electric eye, as they are mounted on the front and rear fenders, may also be adjusted to vary the point or position of intersection of the axis of the electric bulb and the electric eye. They, too, may be altered in their downward slant of installation for focusing light on the curbstone or roadside object.

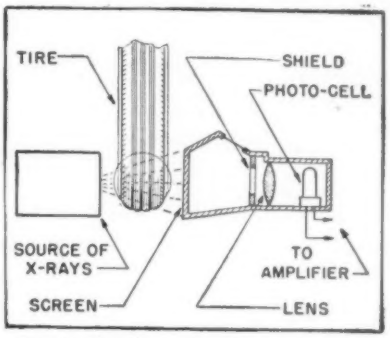


Fig. 1—The electronic auto tire inspector.

Of the approximately 30,000,000 passenger

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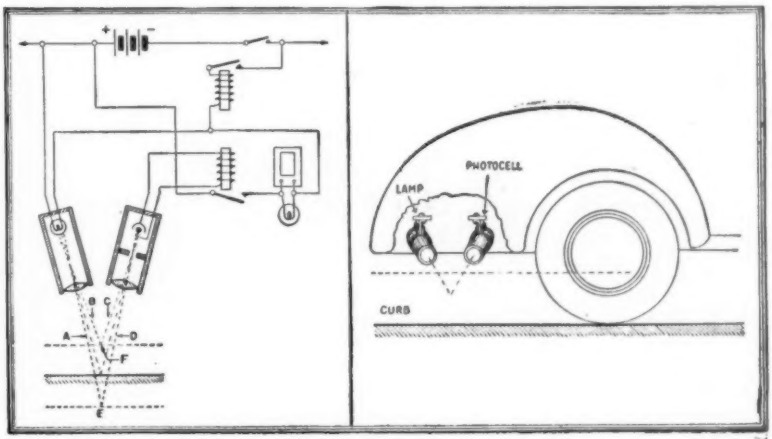

Fig. 2, left—How rays reflected from the curb control the car; right—in place beneath fender.

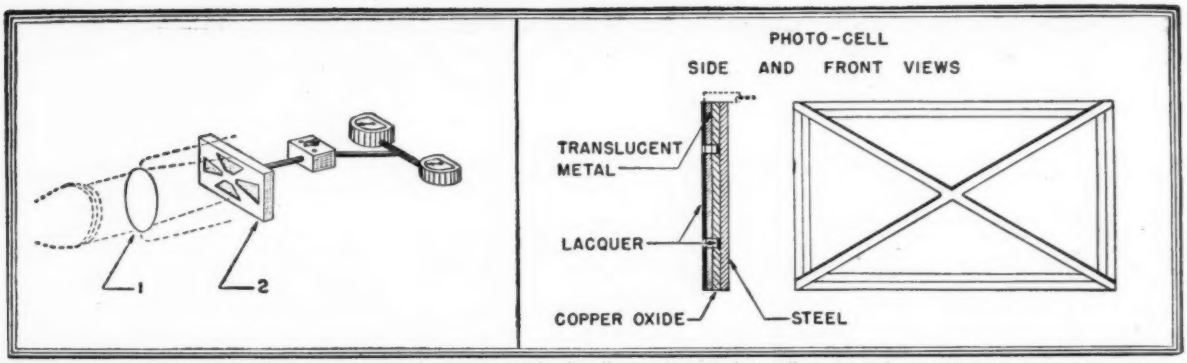

Fig. 3—An automatic electronic meter for checking automobile headlamps. It uses photocells and a balanced circuit actuating two meters.

automobiles in the United States, about 10,000,000 have been taken off the highways by the necessary stringency of gasoline and tire rationing. Several other million cars are limited in their travel by fuel restrictions, and petroleum and rubber authorities are issuing grim warnings that available automobiles in 1944 must be conserved as instruments of war—transporting men and material to and from armament and airplane factories. This means that engines, batteries, ignition systems, crank cases, anti-freeze solutions, and headlights must be preserved by judicious care and frequent testing. An electronic device for automobile headlight testing has been invented for the General Motors Corporation by Thomas W. Meeder of Indianapolis, Indiana. Eliminating the possible errors of human judgment in focussing and measuring the amount of illumination in the present method of testing headlights, a series of photoelectric cells scientifically aims the headlights subject to scrutiny and then measures accurately such light intensities. During this war or afterward, electronic engineers will have the opportunity of installing and servicing this General Motors' apparatus in thousands of service stations and at Federal and State automobile testing stations.

Shown in Figure 3-a, the lens and photoelectric cell assembly are indicated by the numerals 1 and 2. The cell may be contained in any suitable housing, at the forward end of which is stationed the condensing lens, which casts an image onto the photoelectric cells at the rear of the housing. This image may fall directly on the photocells, or a screen of any suitable light-excluding material may be interposed, with a series of four openings, as indicated in the diagram. The inventor has discovered, by practical experiments, that the most favorable results are obtained by having the image slightly out of focus at the point where it falls upon the light-sensitive cells. The distance from the focal point is not necessarily appreciable —nor is it critical—just sufficiently out of focus to spread the image. A switch assembly is employed to effect the required connections between the photocells and the two indicating meters. If a screen of light-impervious material is used, it is mounted immediately ahead of the light-sensitive cells.

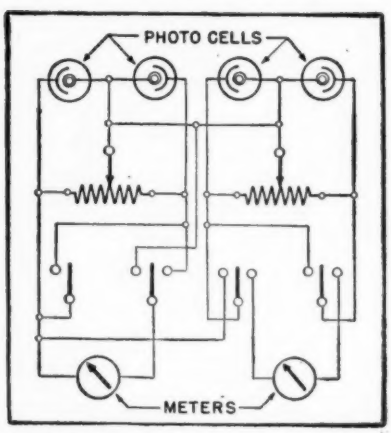

Fig. 4—Schematic of the auto headlamp tester.

Of the various types of photoelectric cells, the "barrier-layer" is preferred by the inventor for his electronic automobile headlight tester. It is photo-voltaic—generating a voltage, the magnitude of which depends upon the strength of the light falling on its sensitive surface. The "barrier-layer" type of cell is comprised of a metallic plate, with a layer of some substance such as selenium or copper oxide over it. This plate may be flexible, though the diagrams (Fig. 3-b) show a rectangular form. It is coated with a translucent metal sheet, the latter having a raised portion near its periphery. Diagonal cuts are then made down to the plate, thus forming grooves. A moisture-proof coating, such as lacquer, is sprayed over the face of the assembly. The lacquer, desirably so, makes its way to the bottoms of the grooves. There is no arbitrary manner of doing the spraying, provided the raised portions near the periphery remain uncovered. This may be insured by use of a mask, or the raised sections can be sprayed and then scraped or washed.

The diagonal cutting of the metallic plate means that the barrier-layer is divided into four distinct sections—comprising an equal number of photoelectric cells. They have a common terminal, of any polarity, in the form of the metal-backing plate, and separate terminals of the opposite polarity, in the form of the raised marginal portions. The lacquer at the bottoms of the grooves is insurance against short-circuiting between nearby sections, which might be caused by moisture collecting at the bottoms of these grooves. There are two potentiometers for calibration purposes. One of these potentiometers is connected across the independent terminals of the two vertical segments of the photo-cell, and the other across the two horizontal segments. A variable center tap is provided so that, with equal amounts of light falling on each one of a pair of segments, the voltage across each side of the potentiometer is equal. Meters are connected in the circuit of each pair of plates, as shown in Fig. 4. It may readily be seen that, with all sections of the photocell equally lighted and the potentiometers properly balanced, there will be no flow of current through the meters and their indication will be zero.

In actual practice, the test-head is aimed by aligning sights provided on it, with reference points on the automobile, the lights of which are to be tested. The head is then shifted into position in front of the headlight, while at the same time maintaining its axis parallel to the direction in which it has been aimed. The test-head is now in position so that if the headlight is truly aimed and focused, light of predetermined relative intensity will fall on the photoelectric cells. To achieve this objective, the cells must be calibrated as to sensitivity to set such a headlight. For the latter purpose, it may be desirable to insert variable resistance units (not shown in the diagrams) in the four electrical conductors. Most favorable results, experiments have indicated, are accomplished when the apparatus is set up so that the lens will be situated 18 inches or less from the headlight lens.

By use of the two potentiometers mentioned above, this electronic device may be employed in the accurate aiming of a beam of light from an automobile headlight. With the photocells in the position shown in Figure 3, a reading of the meter other than zero will indicate whether the beam of light is too high or too low. Appropriate markings on the scale of the indicating meter will tell to the operator how much the beam is off the correct line, whether the beam is straight ahead, or to the right, or left, as well as up or down. The device also measures the candlepower of total light values of all the sections involved, thus indicating precisely the candlepower of the headlight under test. Thus individual perception, which varies with individuals, is no longer an uncertain factor in testing automobile headlights—the variable human equation gives way to electronics, which can grade 2,000,000 shades of color or measure the intensity of a beam of light with the finiteness of micrometer-like precision.

●

A new three-minute test of night vision is being installed in Navy ships and training centers to help in checking the fitness of men for duty as night flyers, night lookouts and other work requiring "cat's eye" vision.

Apparatus for the test is portable and consists of a luminous dial made of radioactive material sandwiched between two discs of glass. The dial has a very faint glow. This illumination can be cut down still further by the use of filters. It is necessary for the man taking the test to distinguish a letter T, showing up very faintly in silhouette against the glowing dial. He must tell the position of the letter as it is rotated by the examiner.

Sally, the Service Maid

The Case of the Dual Volume Control

By NATE SILVERMAN

SALLY MASON opened her radio shop early this fine summer morning, briskly dusted off her benches and her desk, placed freshly-picked flowers in the vase on her desk and whistled cheerfully, if slightly off key. Her favorite tune, for the moment, happened to be Beseme Mucho.

It was wonderful, just being alive on such a glorious day! She swept the floor of Sally Mason Service Maid, again dusted her desk and studied the diagram of an Edison radio combination. The schematic told her this ancient 8-tube radio-phonograph, using five 27's, two 45's and an 80 was a tuned radio frequency circuit. But she had known that, yesterday.

The dual volume control, with a single-pole single-throw switch for the A.C. Line did not worry her; that was standard. But this volume control had a single-pole double-throw switch, which she had been too busy to trace, yesterday. Too busy.

She put on her shop coat, sat down at her desk and her straight little nose wrinkled, then she frowned. A dual volume control with two switches was something she had never before encountered. But she would figure it out—or else!

The phone rang and she said: "Radio! Sally Mason, Service Maid . . . Yes, Mrs. Cartwright . . . yes, I have . . . No, not yet. No. . . . I don't think these controls are available . . . Of course! . . . Yes, I'm studying the diagram this very moment . . . Who knows? . . . Yes, Mrs. Cartwright . . . Thank you, Ma'am."

She hung up the receiver and began to stare at the schematic. So that extra switch was for the phonograph! Well! It had taken her a long time to solve that. But she had!

Sally walked to her bench, turned the tuner section of the chasis over and inspected the volume control. Yes; just like the diagram. Then she shrugged. So what? What good was it? Without an exact replacement, which meant she could not complete the job, she had succeeded merely in wasting her very valuable time. Next time they came in with an old radio she'd examine the volume control, first thing!

Her little hands became very busy, as she began to replace the dial cord on a Philco table model. Her mind was busier. Much busier than her flying little hands. She wondered if Dad, who was a thousand miles away, teaching radio fundamentals to men and women in the armed forces, could do anything about that Edison with its incredibly complicated, unavailable volume control.

It made her grin, just to think of Dad. He could do anything in radio—or almost anything about . . . well, anything! Almost tempted to write and ask him for help, she gritted her teeth and clenched a small fist. No; Dad didn't raise any quitters!

Many things were on her mind, but one thought persisted in coming to the surface. She fought very hard, just as she had for two months now, not to even think of that husky young soldier boy. Yes, Technical Corporal Dan Bryner had been very nice, very helpful when she had been stuck with that Emerson. Silly of her to have used a 3,000-ohm field speaker to replace a speaker that required only a 450-ohm field!

Well, that dial cord was on; the job was done. What's next? Okay; let's get that Crosley. Probably a burned out 35Z5, or maybe a 50L6. The numbers of the tubes made her remember that the Emerson—the one the Technical Corporal had helped her with—had a 35Z5 and a 50L6. Angrily, Sally tossed her head, and her soft luxuriant brown hair flew in her face. Playfully, she twisted her mouth and blew up at the hair in her face. Then—

Someone was laughing. It was a man's voice.

"Sorry, Miss Mason," said Technical Corporal Dan Bryner, a tanned hand over his mouth, "I just couldn't help it. If you could only have seen yourself!"

Sally cocked her head sidewise and inspected him. He misunderstood her sudden flush of embarrassment.

"I'm sorry, Miss Mason," said the Technical Corporal. Then he shrugged his heavy shoulders and grinned. "Every time we meet, I make you angry! I wonder what it is about me that you so dislike."

Sally's warm smile made him grin. "You were kidding," she said, "so why can't I have fun, too? Good morning, Technical

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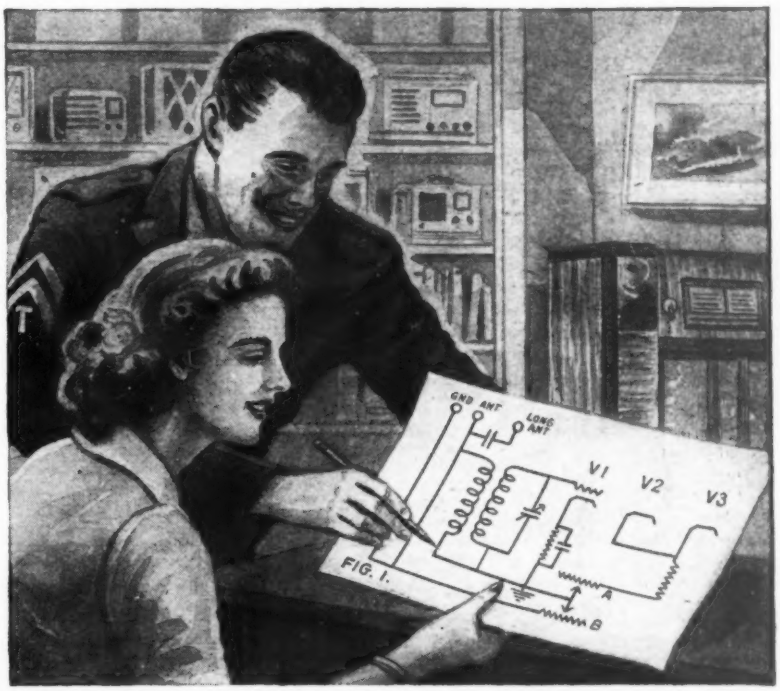

Fig. 1, above—Sally and the Corporal get to the heart of the Edison volume control circuit. The dual variable resistor is the unrepairable and irreplaceable component.

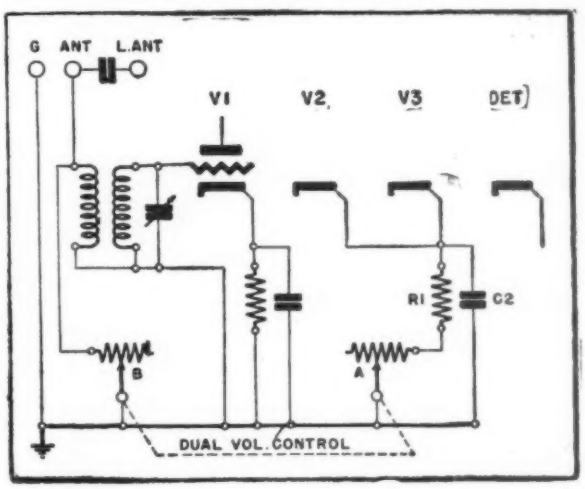

Fig. 2, right—Breakdown of the circuit in Fig. 1, showing the function of each part. One section of the control shunts the aerial, the other controls R.F. cathode bias.

COVER FEATURE

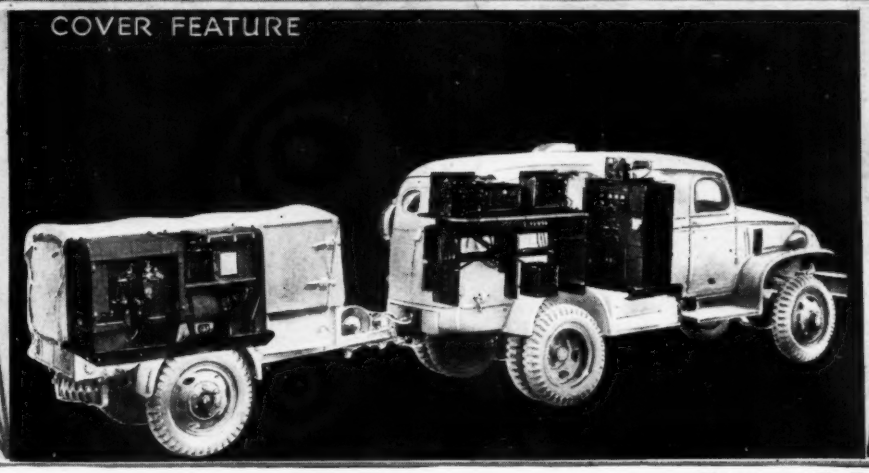

Photo courtesy The Hallicrafters

MOBILE RADIO STATION

THE "Mack Truck Portable" is a term which has come down to us from the earliest attempts to build radios that could be carried. Some of these were so bulky and heavy that the idea of a truck to carry them suggested itself automatically. It remained for the present global war to make such a "portable" a reality. And reality it is, in the Signal Corps mobile radio station, SCR-299, illustrated on our cover this month.

The SCR-299 is normally carried in a 1½-ton army truck, and also appears in other conveyances, such as the motor trailer shown in one of the accompanying illustrations. It has been mounted on a caterpillar half-track for use on the sands of Africa and may yet turn up on a propeller-driven sled for use in a Northern winter.

In a word, the SCR-299 is the ultimate in mobility and power. The transmitter is the Hallicrafters HT-4, modified to meet the exacting specifications necessitated by its work as a mobile radio. It is a 450-watt voice and C.W. set, which had been thoroughly tested and proved as an amateur rig before being drafted into the service of the country. It is powered—as are the receivers and an electric heater also installed in the truck—by a 117-volt Onan generator in a trailer behind the truck. The equipment includes two stan-

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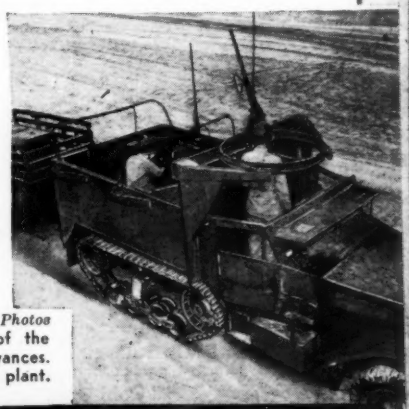

Signal Corps Photos

The five illustrations show several views of the Army's SCR-299 in various types of conveyances. Phantom above is a good view of the power plant.

electronic ALARM

The device described below was originally used as a "baby alarm," but may be adapted to a large number of different uses. Readers will immediately think of a burglar alarm, "open sesame" door opener, and others. An excellent point is that the apparatus can also be used as a pre-amplifier.

By **J. S. WORTHINGTON**

THE apparatus described was designed and constructed to meet the need of a warning that a baby was awake and crying, the bedroom being some distance from the sitting room and cries very difficult to hear (especially with the radio on!). It could also be arranged to give a warning in the garden or anywhere else required. The sensitivity is such that a low moan or whimper two feet from the microphone will cause a relay to close, so operating a buzzer at the remote point.

The heart of the unit is the rectified feedback stage shown in Fig. 1. The valve is biased so that the relay will just release after being operated. When a signal is impressed on the grid it is amplified and fed back via C2 and the rectifier—R2 network. Due to the rectifier a D.C. voltage is built up across R2, in opposition to the fixed negative bias. This is applied to the grid through the de-coupling resistor R1. Increased plate current passes and the relay operates. The rectifier used was of the metal type but there seems no reason why a 6H6 or other tube should not be equally good.

Using a carbon microphone with 20 Ma. current through it, good results were obtained with this circuit, but sensitivity was hardly adequate for the purpose, though normal speech one foot from the microphone gave reliable operation. The relay used was of 1,000 ohms resistance, operate current 2.1 Ma., release current 0.5 Ma. No doubt a more suitable relay would improve the sensitivity, but such things are not easy to obtain in wartime.

To obtain adequate sensitivity an amplifying stage was added, resistance-capacity coupling being used with a high-mu triode. This resulted in the circuit arrangement shown in Fig. 2. The amplifying stage is normal in every way; neon-bulb stabilization of H.T. voltage was incorporated, and the adjustable bias necessary for the relay tube was obtained from a potentiometer across the supply. The neon lamp was of the pilot lamp type and was actually mounted behind an aperture in the panel.

The apparatus at this stage performed its duties very satisfactorily, but it was realized that it also contained the essentials of an efficient pre-amplifier. In these days of shortage the prospect of combining several functions in one piece of apparatus had great attractions. By providing an input volume control and arranging to use the feed-back condenser C2 and the impedance of the relay winding as output coupling components and disabling the rectifier network, at high gain, high quality amplifier was available. These changes were made very simply, by incorporating an output jack which was made to perform the necessary switching as shown in Fig. 3. The cathode by-pass capacity was also increased and a dual purpose input transformer installed.

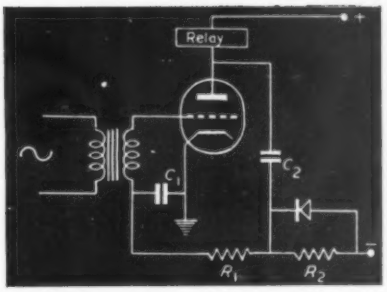

Fig. 1—A rectified feedback unit builds the signal up to trip the alarm-energizing relay.

An additional refinement incorporated at this stage was the inclusion of a resistor in the negative return lead to provide microphone energizing current and so eliminate the microphone battery. The heater supply was used to operate the remote buzzer to make the unit completely self-contained. When used as a straight amplifier the bias control for V3 should be set so that the tube draws its normal plate current for class-A operation. An attempt was made to improve the device by including a coupling choke in series with the relay winding, but the improvement when used as a straight amplifier was negligible and operation as a relay was impaired owing to the consequent slowing of the D.C. rise and fall due to the inductance, so it was omitted in the final version.

Adjustment is very simple, all that is necessary being to reduce the bias on V2 by the variable resistor until the relay operates, then, making sure the microphone is plugged in and the input volume control at maximum, increase the bias slowly until the relay just releases. After this the input volume control can be set at any level.

The power supply used for this apparatus is fed directly from the A.C. line. This A.C.-D.C. circuit is only suitable where one side of the supply mains is grounded and care must be taken to see that the grounded side is so connected that it becomes the negative side of the output as one side of the microphone circuit is directly connected to negative high-voltage.

A single-section filter proved adequate to reduce the hum sufficiently for relay working though an additional filter section

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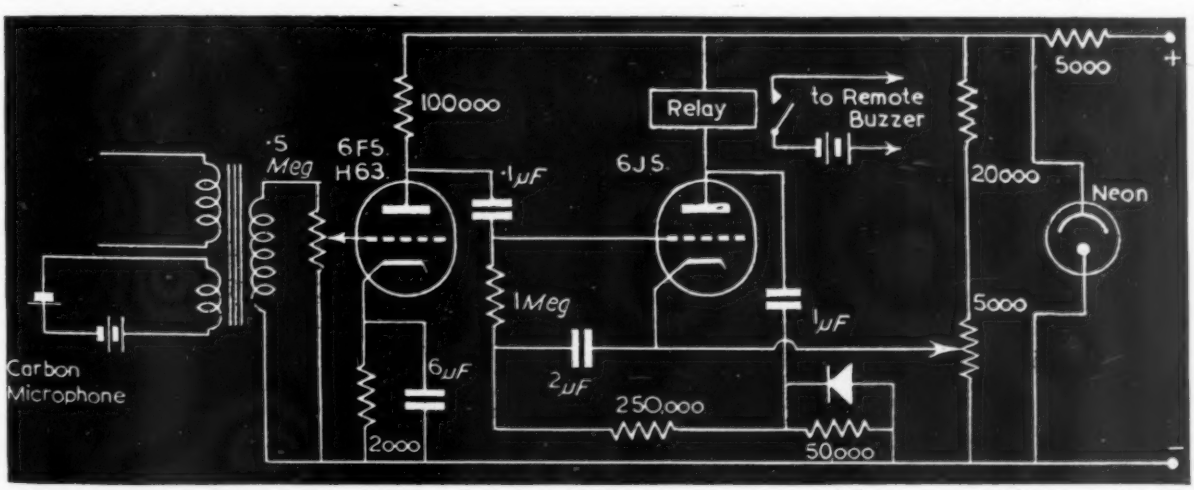


Fig. 2—Complete diagram of the relay circuit, showing the combination input transformer, which permits operation as alarm or amplifier.

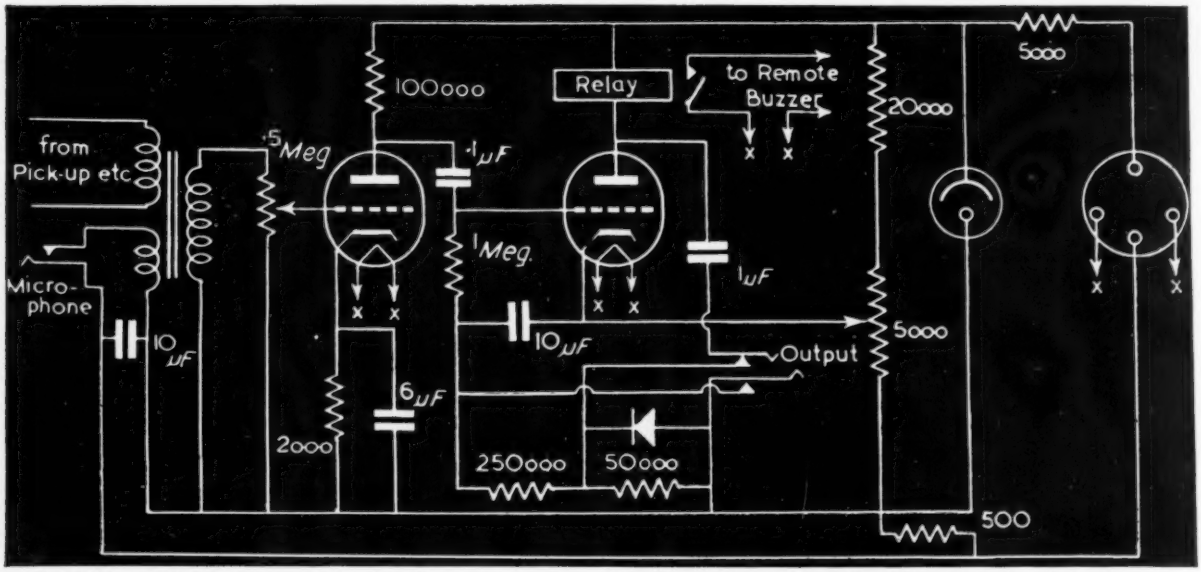


Fig. 3—By a switching arrangement, the alarm becomes an audio amplifier when not in use as an alarm. This makes it two devices in one.

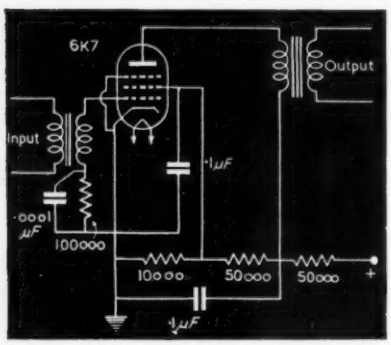


Fig. 4—Supplied with a limiter, as above, the apparatus will operate a tape recorder.

is desirable for use as an amplifier. For this reason the power supply was built as a separate unit, both units being provided with tube sockets for termination of supplies and connected together by a multicore flexible cable fitted with a tube base "plug" at each end. When operation as an amplifier is desired a high quality A.C. power supply, normally used for other purposes, is plugged in place of the simple unit described above. This system of inter-connection has long been adopted as standard on all the writer's apparatus and has proved very flexible.

By using the amplifier on a power supply which can also be used for other purposes, and by also having it fitted up so that it can be used as both alarm and amplifier, a multiplicity of uses can be secured from a small amount of apparatus.

The uses to which the Rectified Feedback Relay Amplifier can be put are many. For instance, it is very suitable for controlling a tape recorder from the output of a receiver. High level input is not essential, reliable operation being obtained with a peak A.C. input to the stage of 1 volt. In such an application it is advantageous to use a limiter stage between the receiver output and the relay stage to smooth out any variations in signal strength. Such a limiter stage is usually of the plate saturation type where low plate and screen voltages are used to limit the plate current at high signal amplitudes. A suitable circuit is shown in Fig. 4.—*Electronic Engineering, London.*

South Seas "Radio City"

THE crude board shack illustrated is more important than its appearance would suggest. It is the central (and at present, the only) station of the Mosquito Network, of Guadalcanal and the South Seas.

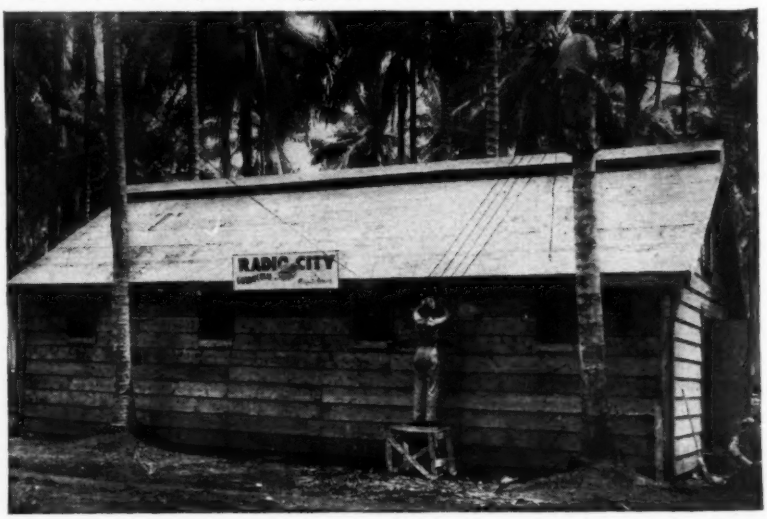
The new studios and transmitter, set up under direction of the Armed Forces Radio Branch of the Morale Services Division of the War Department, are housed in a typical muddy grove of coconut trees in a central section of the island. The studio, a 20 by 40 foot board shack, is the last word in Guadalcanal luxury. Consisting at present of two rooms, a combination office and control room and the studio, its plans immediately call for soft-color decorations, involving a mosquito motif, in keeping with the "Mosquito Network," name adopted.

Broadcasts are regularly scheduled each day from 5:30 to 8:15 a.m.; 11 a.m. to 1 p.m., and 5 to 10:05 p.m., times most suited for listening by the troops. The programs, under direction of Captain Spencer M. Allen, include news, entertainment and spiritual talks by chaplains, as well as recorded music and variety shows shipped in from the United States. Local special events, band concerts, religious ceremonies, and prize fights are also presented.

All equipment, including a horizontal Marconi antenna, strung between two 60-foot coconut trees, was installed by Army engineers and signalmen under supervision of Captain Wilford H. Kennedy, formerly with WKRC, Cincinnati, Ohio. Inside units include a Rosen console, two Audax turntables, two RCA ribbon velocity and two Astatic dynamic microphones. All equipment is impregnated with a special compound against the excessive humidity.

The transmitter, an RCA 1 kilowatt high efficiency rating unit, powered by a Signal Corps 7½ KVA generator run by a jeep motor, radiates a strong signal from 35 to 50 miles. Reception at night under favorable conditions, however, extends several hundred miles. The assigned frequency carrier is 730 kilocycles.

The Guadalcanal station is the second of its kind in the South Pacific. Another, in Noumea, New Caledonia, has been in operation several months.



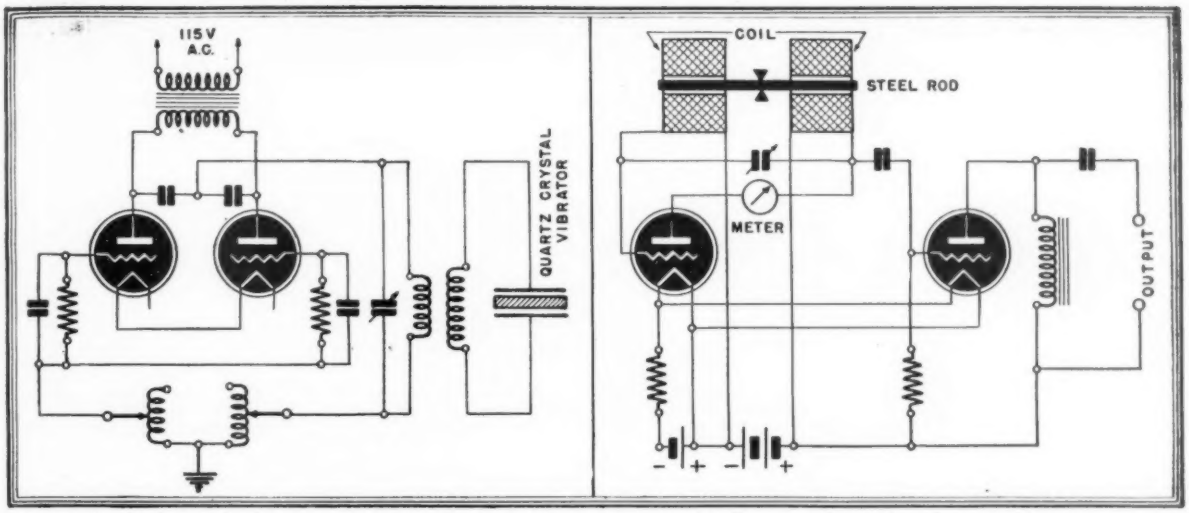


Fig. 1, left—A crystal circuit for producing supersonic oscillations. Fig. 2, right—The magneto-striction circuit for the same purpose.

Industrial Electronics

PART VI — SUPERSONICS

By RAYMOND F. YATES

THE province of sound has long since been invaded by the electron in its conquering march through the arts and the sciences. Aided by electronic devices, sound has turned out to be an important source of a new and mysterious form of energy. Sound is not only amplified by the aid of the electronic tube but it is created by it, in a large range of frequencies. The recording and reproduction of the human voice and music amounted to little until the electronic tube began its long and useful career in telephony and radio. Indeed, if we stop to think about it, a very large portion of the electronic business of today involves the amplification, recording, reproduction and radiation of sound. These are the ordinary, run-of-the-mill applications. Not so well known is the new and fascinating supersonics.

It is easy to produce electrical vibrations of a very high order. With short-wave oscillators, electrons can be made to swing back and forth in circuits millions of times a second. However, we have no sound reproducing apparatus that would respond to these prodigious speeds. If we should let such currents flow through an ordinary loud-speaker, nothing but silence would prevail. In the first place, the diaphragm of the loud-speaker would be too bulky and massive to respond to these rapidly-moving currents, and even if it were able to respond, the human hearing apparatus would not be able to detect the sounds produced. Twenty thousand vibrations per second represents the absolute limit of the capacity of the human eardrum.

In his search for a "loud-speaker" that would dance to the tune of these ultra-rapid vibrations, Professor Robert W. Wood, of the Physics Department, John Hopkins University, turned to the use of quartz crystals. It is a well known fact that a plate of quartz, cut from a crystal in the proper direction, has the property of expanding and contracting under the influence of a periodic electrical field which may be supplied by two thin metal plates in contact with its opposite surfaces and joined to the terminals of a high-frequency electrical oscillator of sufficient power. Calculations show that a quartz crystal or plate 1 cm. in thickness will respond to a natural frequency of about 300,000 vibrations per second. Consequently, if the crystal is placed in a circuit of powerful electrical oscillators tuned to the same frequency, resonance occurs, and the amplitude of the vibrations of the quartz crystal becomes very great. It is by the use of a crystal of this type that Professor Wood was able to study the mechanical effects of such astounding rates of vibration.

SUPER-SOUND WAVES

The "silent" sounds produced in this way are capable of many curious feats. A glass tube, vibrated at a rate of 300,000 oscillations per second, will sear the flesh of the fingers if it is squeezed tightly. Benzol on water is thrown into such violent action that it is driven off into the air as fine mist or smoke. Frogs swimming in liquids vibrating at this high rate are killed, and glass tubes eventually succumb to the supersonic frequencies that disrupt the ordinary molecular organization.

While ordinary quartz crystals such as those employed in amateur transmitters may be made to vibrate at super-audible frequencies by the use of a small oscillator, the amplitude of their vibrations is very small and unsuited for the work which Dr. Wood undertook. To obtain sufficient intensity, a 2-kilowatt oscillator which had originally been designed for an induction furnace was used, together with a bank of oil condensers and a large variable air condenser used with several pairs of coaxial coils for raising the voltage. The primary coils were made up of from 7 to 20 turns of Litzendraht cable, the resulting coils varying from 16 to 20 centimeters in diameter. The secondary coils, wound on glass cylinders and containing from 100 to 250 turns, were mounted within the primaries.

Equipped with this generator of supersonic frequencies, a diagram of which is illustrated in Fig. 1, Professor Wood set out to explore the wonderland of sounds that burn and explode. By the use of this apparatus with a quartz crystal cut to suitable size, sounds—if they may be called sounds—were generated with frequencies of from 100,000 to 700,000 cycles per second. The plates, which were in the form of circular discs, rested on sheets of lead

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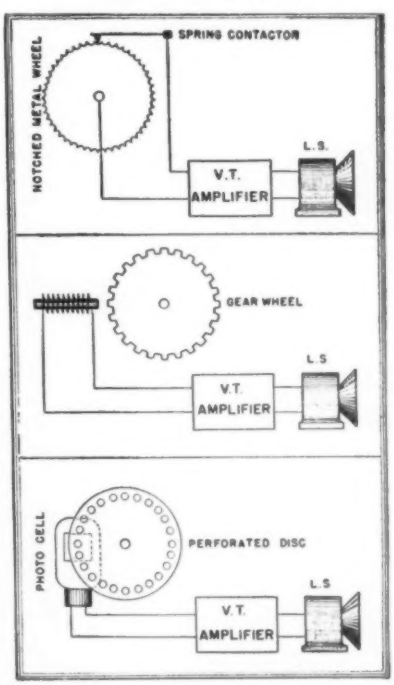
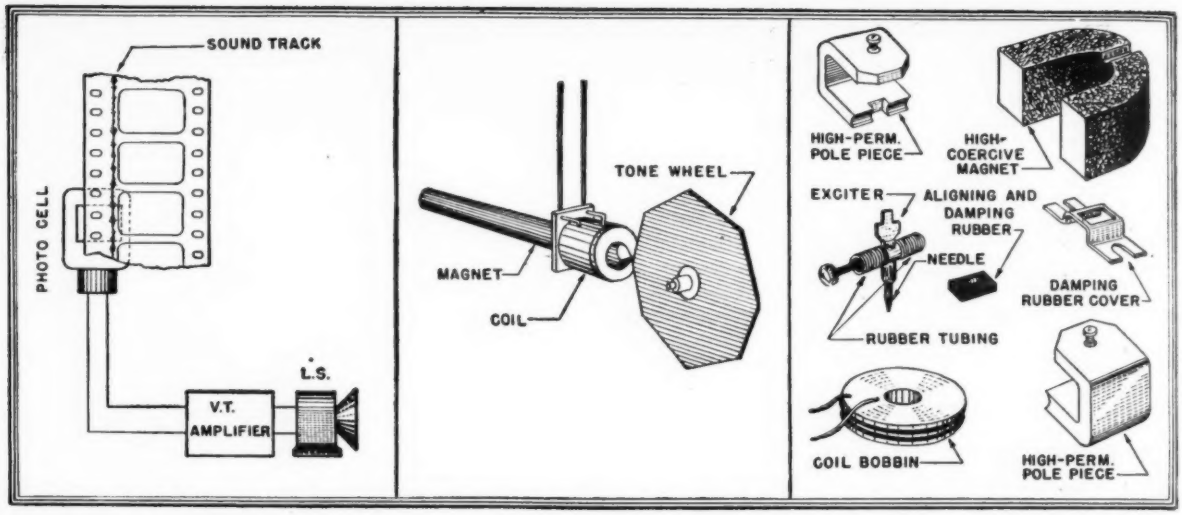


Figs. 3, 4 and 5—Mechanical, magnetic and photoelectric methods of producing oscillations.



Producers of sonics, or sound. Fig. 6 is the Movietone system, Fig. 7 the tone-wheel of a Hammond organ and Fig 8 a phonograph pickup.

at the bottom of a dish of transformer oil. The top electrode, which was formed by a disc of very thin sheet metal, rested on the upper surface of the quartz.

It was during his early researches that Professor Wood found that it was necessary to immerse the quartz in oil, to accommodate the potential of 50,000 volts generated by the powerful oscillator. With the use of such high voltage, it was found impossible to produce the effects outlined without the immersion in oil. Not only would there be sparking around the edges of the electrodes but the quartz plate would be broken to pieces as a result of the extreme vibrations induced in it by the action of the currents. By immersing the crystal in the oil bath, sparking was overcome and part of the energy imparted to the crystal was sufficiently dissipated by compressional waves in the oil. Even with this arrangement, Professor Wood was always on the borderland of danger; for it was found that increasing the voltage much beyond 50,000 resulted in a loss of crystals.

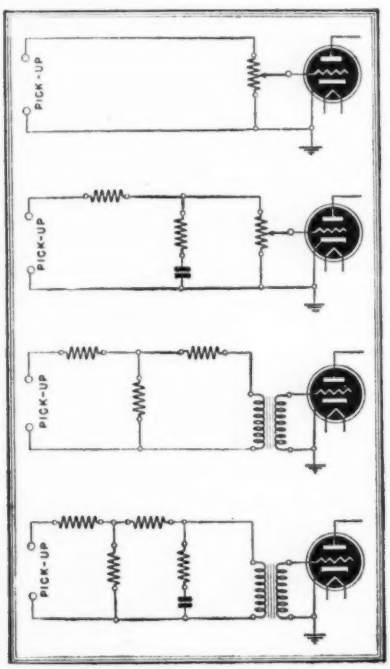


Fig. 9—Methods of pickup-amplifier coupling.

STRANGE EFFECTS OF SOUND

A beaker of water lowered to a point beneath the surface of the oil demonstrated a most remarkable phenomenon. The supersonic frequencies at which the molecules of oil were responding was instantly communicated through the glass to the water in the beaker. The surface of the water was at once pushed up into a mound, while millions of infinitesimal air bubbles appeared in the fluid. When water is heated, precisely the same effect is produced; there is a rapid movement of dissolved air in the form of bubbles to the surface of the water. In this particular case, however, the bubbles did not go immediately to the surface but became entrapped in the nodes of the standing waves which had been formed by interference from the direct waves with those reflected down from the surface. When subjected to the same process, mercury was blown into clouds of fine particles projected up through the water, which soon became as black as ink.

Maximum heating effects were produced with a small flat-bottomed conical flask drawn out to a rod of about ½ millimeter in diameter at the top. The flask was mounted on a solid support in a vertical ring and pinion device, and the distance between the flask and the crystal plate could be accurately adjusted. By bringing pine chips in contact with the top of the rod, these were caused to emit sparks and holes were burned through them.

When a chip of wood was pressed tightly against a glass rod in contact with the sound generator, the rod was set to vibrating at high speed, and the chip burned. When the same glass tube was permitted to come in contact with a plate of glass, it pushed its way through, displacing the glass in the form of fine white powder. By dusting circular glass plates with lycopodium, and subjecting the plates to the ultra-rapid vibrations, the powder arranged itself in symmetrical forms having a lace-like appearance.

Among other interesting experiments performed by Dr. Wood was that of drawing out a glass tube and spraying the constructed area with oil. When exposed to the vibrations by placing the bottom of the glass tube in contact with the rapidly vibrating supersonic generator, the oil escaped into the surrounding atmosphere in the form of fine mist or spray, which fully demonstrated the exceptionally violent action into which the molecules were thrown.

Perhaps the most interesting experiment of all these many experiments was that which tested the biological effect produced by the vibration. Red blood corpuscles were completely destroyed and the salt solution in which they are suspended quickly lost its turpidity and became a clear, red color very similar to the solution that would be produced by analine dyes. Unicellar organisms, such as paramecia, were almost instantly dispatched and the cells torn open.

Supersonics will one day find use in medicine, perhaps in surgery and certainly in chemistry and biology. The diagram, Fig. 1, does not represent the only method used in the creation of supersonic waves. There is also the magneto-striction oscillator based on the 1863 discovery of Phillip Reis who found that steel or iron rods changed their lengths or expanded and contracted to a slight degree when magnetized. Thus alternating current or modulated direct currents made such rods vibrate in a microscopic sense.

PRODUCING SUPERSONICS

When an iron rod is arranged concentrically within the two coils as shown in Fig. 2, sound generation may be carried to a very high point. As those familiar with the simple regenerative circuit will see that this magneto-striction circuit, developed by Dr. G. W. Pierce of Harvard University, is essentially an Armstrong circuit.

Other means for the generation and magnification of sounds by electronic means are illustrated in Figs. 3 to 6. The first method is purely electrical rather than electronic but the other methods involve electronic amplification. The one shown in Fig. 4 may be duplicated experimentally by revolving an ordinary gear wheel near the poles of a sensitive telephone receiver. A second telephone receiver connected to the first will give off sound, the frequency of which will depend upon the number of poles (teeth) on the gear wheel and its r.p.m.

This very principle has been applied in the Hammond and other electronic organs. The actual rotor of the Hammond machine is illustrated in Fig. 7. This peculiar shape is used to generate a precise wave form. Current from the simple generator shown

(Continued on page 688)

PRACTICAL ELECTRONICS

PART V—RECTIFIERS HIGH-VACUUM AND GAS-FILLED

By **FRED SHUNAMAN**

ELECTRON-TUBE rectifiers make direct out of alternating current. Electrons are emitted from the hot cathode in great numbers and flow readily from it to a plate in the tube if that plate is kept at a voltage more positive than that of the cathode. If the plate is negative and the filament positive, a negligible number of electrons are emitted from the cold plate (at ordinary operating voltages). So, if voltage is applied first in one direction, then the other, the tube will seem to have a very low resistance (speaking in terms of Ohm's law) when the negative voltage is on the cathode, and a very high resistance when it is on the plate. See Fig. 1.

It is necessary to know something of the characteristics of the dozens of different types of electron-tube rectifiers, if we are to use the right one in the right place. It is also important that the tube not only be properly selected for the job, but be operated under the right conditions. This is especially true for the gas-filled rectifiers. These tubes are very easily damaged if carelessly operated or abused.

Complete information on ratings and operating conditions may be obtained from receiving tube manuals for smaller types, and from the technical data sheets issued by manufacturers, for the larger industrial tubes.

High-vacuum tubes, such as are used for rectifiers in most radio receivers, are simpler and more rugged. They have four important characteristics which must be considered; peak current, average current, peak inverse voltage and forward voltage. *Peak inverse voltage* (Fig. 2-a) is the amount of back-pressure the tube will stand before "breaking down" and carrying current from plate to cathode. When this occurs the tube ceases to be a rectifier, and there are serious consequences. Such an *arc-back* is likely to release gases from the metal elements of the tube, and make it a poor type of gas-filled rectifier, with characteristics altogether different from the original ones. Several arc-backs may destroy the tube's usefulness entirely.

A tube subjected to high inverse peak voltages may short across between the wires leading through the stem, in glass tubes. In such cases the glass cracks and the vacuum is lost, ruining the tube immediately.

Peak current is another rating important to the safety of the tube. It is the limit beyond which even a few minutes' operation will damage or destroy it. If the current through a rectifier is increased much beyond the peak, sparks will be seen jumping from the filament (cathode). Small pieces of the cathode coating are actually being taken bodily along with the emitted electrons. The cathode is—in most rectifiers—coated with a compound which is a much better emitter of electrons than the metal below it. Once this surface is destroyed, the tube becomes useless.

Possibly the most important characteristic in well-designed apparatus is the *average output current*. This may be increased by faults in the apparatus fed by the rectifier, and thus may increase due to defects in such apparatus. If the rated average output current is exceeded, the tube heats because of bombardment of the anode by the countless electrons rushing toward it. The plate (or plates) become red. If excessive current is long continued, gases are given out which ruin the tube. If the current is not so heavy as to make the tube gassy, its life will still be shortened, due to rapid wearing away of the active cathode coating.

Another voltage often given on technical data sheets is the rated *forward voltage* (Fig. 2-b), (which usually appears in tube manuals as "A.C. voltage, RMS"). It is dependent on the peak inverse voltage, and is usually given for convenience. It does not refer to the voltage between plate and cathode inside the tube, which is the really important one to consider. This *internal voltage drop* depends not only on the forward voltage applied, but on the amount of output current—in other words upon the resistance of the *load*. If that is a low-resistance device, naturally more current will flow into it at any given voltage. As the number of electrons leaving the cathode grows denser, the repelling effect on those still struggling to get out into the tube becomes greater. So, as the electron flow from cathode to plate increases, the voltage required to push the electrons across the space within the tube goes up.

A tube cannot be considered an ordinary resistor, in which double the current will result in exactly double the voltage drop, but it does offer increasing opposition to increasing current. This opposition varies with the amount of current flowing through the tube, so that a tube may seem to have several different resistances, if measured with different currents flowing through it. Therefore the voltage drop in a tube can-

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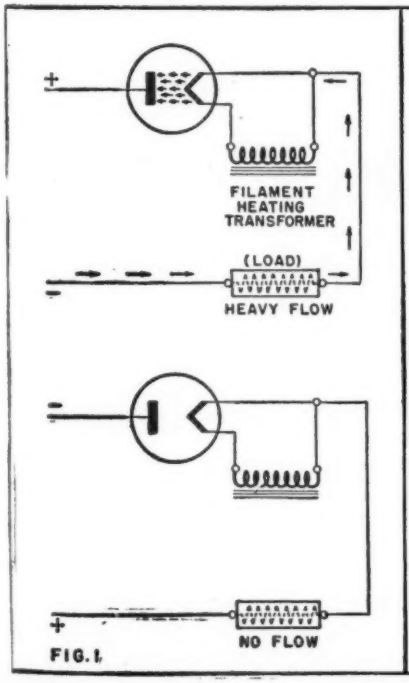


FIG. 1.

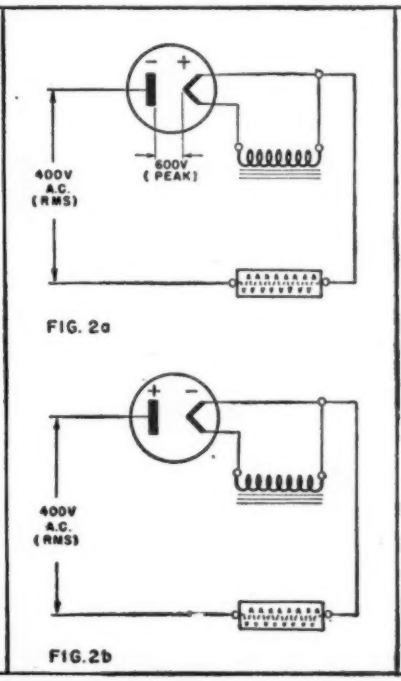


FIG. 2a

FIG. 2b

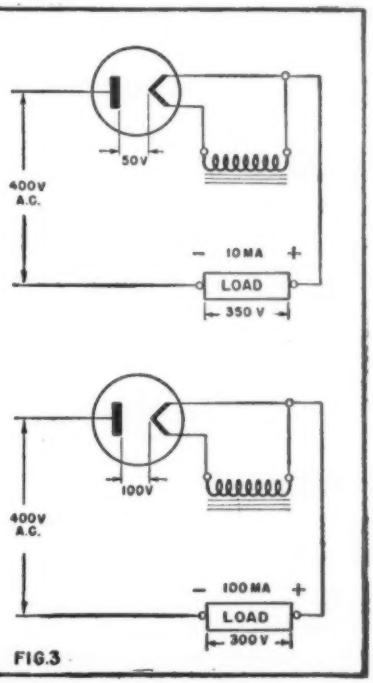


FIG. 3

INDUCTANCE Meter

By I. QUEEN

THE subject of capacitance-measurement has been discussed in recent issues of *Radio-Craft*. It has been shown that such measurements are not at all difficult for the serviceman and experimenter to make. The measurement of coil constants is slightly more complicated due to the fact that some coils possess appreciable self-capacitance.

Fig. 1 shows what occurs when a tuning coil has a comparatively large self-capacitance. It has then in reality a large condenser in shunt with its actual inductance. If the latter requires a given condenser to tune through a range of frequencies, it is quite possible that the self-capacitance is already a good portion of that required. It will then be difficult or impossible to correctly design the tuning circuit other than by cut-and-try.

A knowledge of the actual inductance of a coil is important when tracking is to be done. It is desired that all coils must be very approximately of the same true inductance and self-capacitance. Coil measurements are also of importance where the ultra-high frequencies are involved. Here the physical constants may mean little, since the difference between a coil of 3 turns and one of 3½ turns may prove surprising! Any slight change in shape or spacing of the turns may throw the tuning circuit into another band altogether.

Some measuring device to find whether the desired inductance is higher or lower than desired would save much time in making final adjustments.

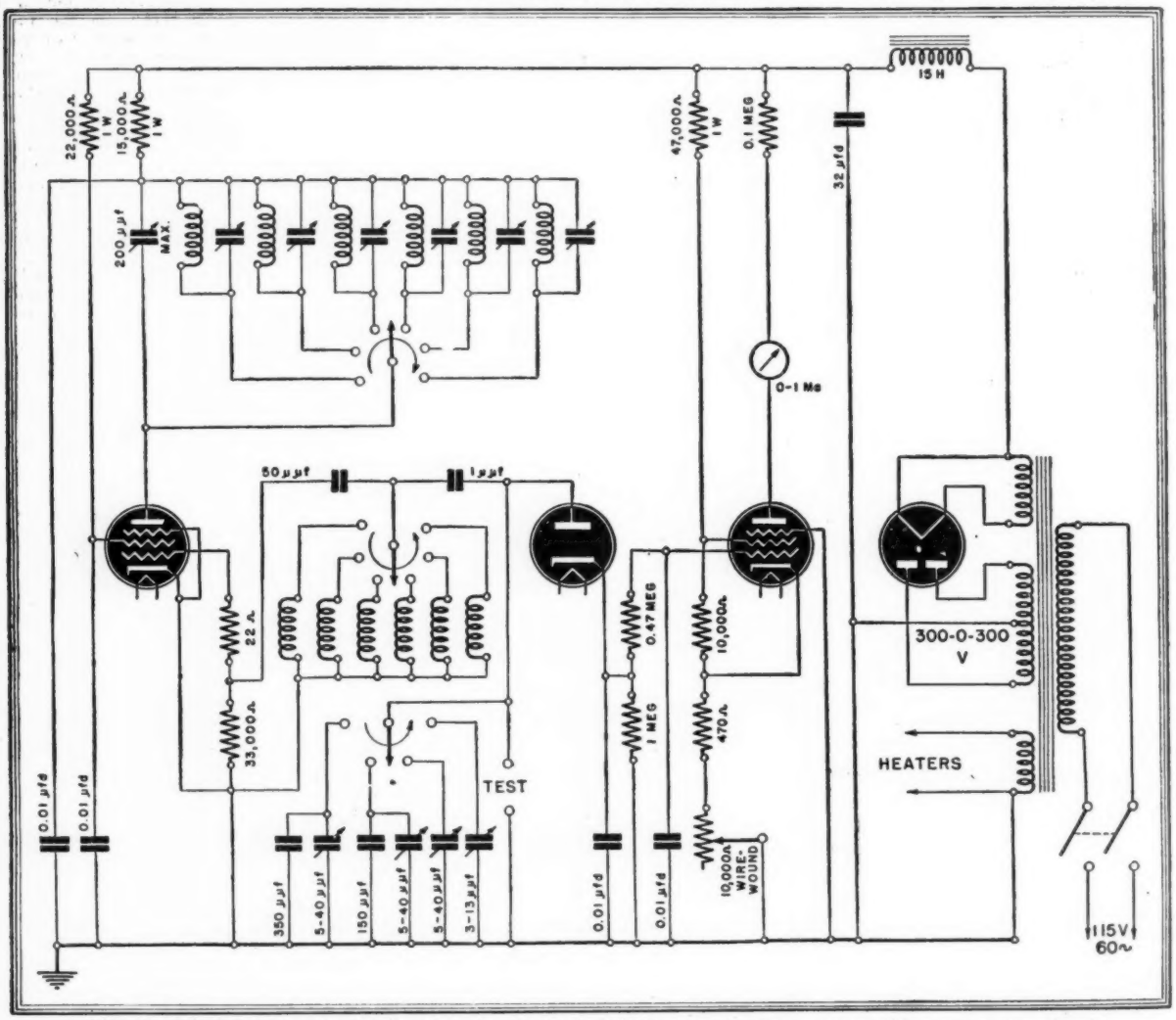
The measuring instrument should be quick and easy to use, cover a wide range of values and be simple to construct. The range of from 1 to 1000 microhenries would cover the broadcast band as well as the ultra-high. For example, a coil of 1000 microhenries will resonate at 500 Kc. when shunted by 100 mmf.

Two general methods are available for the measurement of small values of inductance; the bridge and the resonant methods. The first is difficult to construct for high-frequency operation due to shielding requirements. It is often used at low frequencies, however, and this eliminates the effects of self-capacitance.

On the other hand, at low frequencies, the ratio of resistance to reactance becomes large, and as the bridge user is well aware, much manipulation is necessary since both components must be balanced for a correct null.

The resonant method gives a quick indication and may be used at the frequency at which the coil will probably be used. Unfortunately, the use of but a single frequency does not take into account the effect of self-capacitance. The measurement will therefore show a lower inductance than is actually the case.

The instrument to be described here



Schematic of the inductance meter, including electronic voltmeter for indicating the point of resonance on which measurements are based.

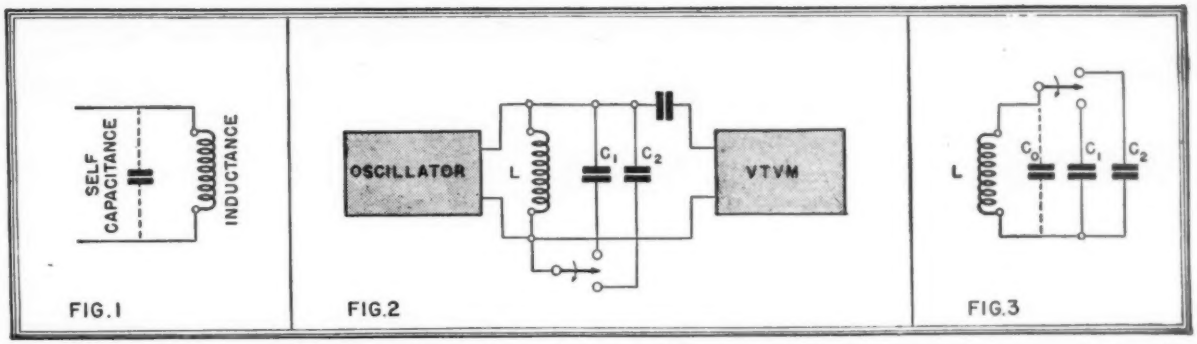


FIG. 1 FIG. 2 FIG. 3

Fig. 1—A coil carries a concealed capacity. Fig. 2—Block diagram of the inductance meter. Fig. 3—Measurements are very simply made.

makes use of *two* frequencies, whereby the effect of self-capacitance is compensated for and the true inductance indicated. Besides, we are in a position to find the self-capacitance should it be required. The device is for laboratory use, and was recently very completely described in *Wireless World* (London). Its construction is well within the means of the serviceman and should find ready application in his workshop.

A block diagram of the instrument is shown in Fig. 2. An all-wave signal generator is tuned by means of a calibrated variable condenser to the resonant frequency of the unknown coil and a known fixed condenser. Resonance will be indicated on the VTVM (which need not be calibrated). Now the coil is switched to another fixed condenser and again resonance is established on the generator. The difference between the two readings obtained on the calibrated condenser of the oscillator is the true inductance of the coil with its self-capacitance accounted for. (The VTVM consists of a diode rectifier and a triode with a 0-1 ma. meter in its plate circuit.)

THEORY OF THE METHOD

We will first develop the required theory so that the reader will not only be in a better position to construct and use the instrument, but he will be able to make any changes in the design to suit his own requirements.

In Fig. 3 the procedure used in taking a measurement is shown. L is the coil to be measured, C_o its self-capacitance, and C_1, C_2 are two known fixed condensers. First we switch in C_1 and tune the oscillator to resonance. The well-known frequency formula is $f = \frac{1}{2\pi\sqrt{LC}}$

The above formula shows that for a given frequency the product of L × C is constant. Since the frequency of the oscillator and that of the tuned circuit are equal we may write $L(C_1 + C_o) = L_2X$ where L_2 is the oscillator coil inductance and X is the oscillator condenser capacitance. L and L_2 must be in the same units. Likewise for C_1, C_o and X.

Switching now to C_2 and tuning for resonance again, we may write $L(C_2 + C_o) = L_2Y$ where Y is the new oscillator capacitance value. Subtracting from the first formula we easily obtain

$$L(C_1 - C_2) = L_2(X - Y)$$

$$\text{or } L = \frac{L_2(X - Y)}{C_1 - C_2}$$

For convenience we make $C_1 = 2C_2$ and the formula becomes $L = \frac{L_2}{C_2}(X - Y)$. *The inductance is then proportional to the difference of the capacitance readings.*

For complete ease of operation we might make $L_2 = C_2$. If the oscillator condenser is directly calibrated in capacitance units, the unknown coil is simply the difference as read on the dial. It is also possible to make L_2/C_2 equal to, say 1/50, in which case the calibrations on the condenser may be 1/50 that of the actual capacitance value. Small numbers on the dial may be much more easily handled, of course, so that the latter procedure will be followed.

The oscillator condenser used in this particular instrument is of the straight-line capacitance type (semi-circular plates) having a range of 50-250 mmf. As mentioned in the previous paragraph we may calibrate it in units from 1-5 if L_2/C_2 equals 1/50. Straight-line capacity condensers were widely used in old-time receivers and are probably readily available. The calibration may be done in accordance with the recent capacitance-measuring articles in *Radio-Craft*. Because of the straight-line capacitance characteristic the calibration will be linear and only a few known points are required. Fig. 4 shows a good arrangement of the final form. The point "1" corresponds to 50 mmf. and the "5" on scale A corresponds to 250 mmf.

For highest accuracy, the calibration could be done after the condenser has been wired into the circuit so that all stray capacitances are accounted for.

Scale B on the condenser is used to extend the available range. When the first scale is in use

$$\frac{L_2}{C_2} = \frac{1}{50}$$

and for the second scale we make

$$\frac{L_2}{C_2} = \frac{1}{10}$$

so that a multiplying factor of 5 is obtained. The values of C_1 and C_2 are fixed at 40 and 20 MMF respectively. This fixes the oscillator coils at values of .4 and 2. microhenries respectively, for scales "A" and "B."

We know that at point "1" on scale A the capacitance is 50 MMF and that the coil has a value of .4 microhenry. Using the well-known frequency formula we find that we should obtain a frequency of 35.6 Mc. at point "1" on scale A. Now with the same coil and a capacitance of 250 MMF (point "5") a frequency of 15.9 Mc. should be obtained.

This gives us several methods for correctly designing the all-wave oscillator. We may calibrate the straight-line condenser (including associated wiring) and then wind the coil to cover the required frequencies at both ends of the dial. Or we may first wind the coil to specified value (.4 microhenry) and then find the proper point on the condenser to bring in the correct frequency. The tuned plate coil determines the oscillator frequency, the grid coil being untuned.

Scale B is used when our oscillator coil is 2 microhenries (multiplying factor of 5). Calculating the frequencies at each end of the dial now we obtain 15.9 and 7.12 Mc, respectively.

Multiplying factors carry the range higher as shown in the table Fig. 5. For instance, an oscillator coil of 4 microhenries being 10 times larger than the original for the A scale multiplies this scale by 10. To multiply by 100, however, it is found that the oscillator coils become large and may exhibit large self-capacitances compared to C_1 and C_2. For this reason, C_1 and C_2 are made 400 and 200 MMF. for this range. With C_2 made 10 times larger, L_2 must be made 1000 times larger to obtain a multiplying factor of 100. The table eliminates the need for calculating the constants for the different ranges.

Note the convenient arrangement for scales C and D. C is the band-changing switch for the six coils used. D switches in the two sets of C_1 and C_2 as described.

In obtaining the values for each C_1 and C_2 the following procedure is followed, (Fig. 4). In order to take into account the various stray wiring capacitances, each of these condensers is in reality a small fixed condenser in shunt with a small trimmer which is varied until the required value is reached.

In setting up the instrument the following procedure is a good one. The variable oscillator condenser may be calibrated (with coil disconnected) at 50, 100, 150, 200, 250 MMF, giving points 1, 2, 3, 4, 5. The smaller divisions are marked off with equal spacing. Now C1 and C2 are adjusted to proper values. Stray capacitances are taken into account by measuring them after they are properly connected into the circuit. As mentioned before C1 and C2 are 40 and 20 MMF respectively, except for the two

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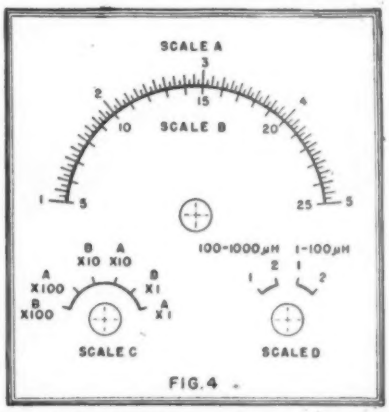
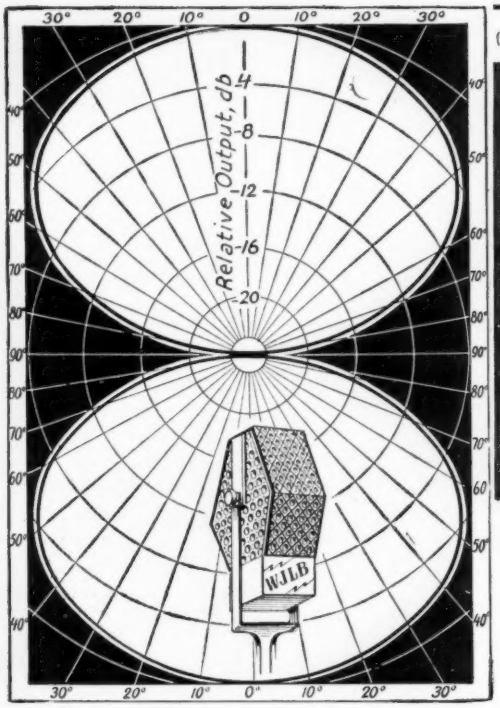


FIG. 4

Fig. 4—The inductance meter's panel layout.



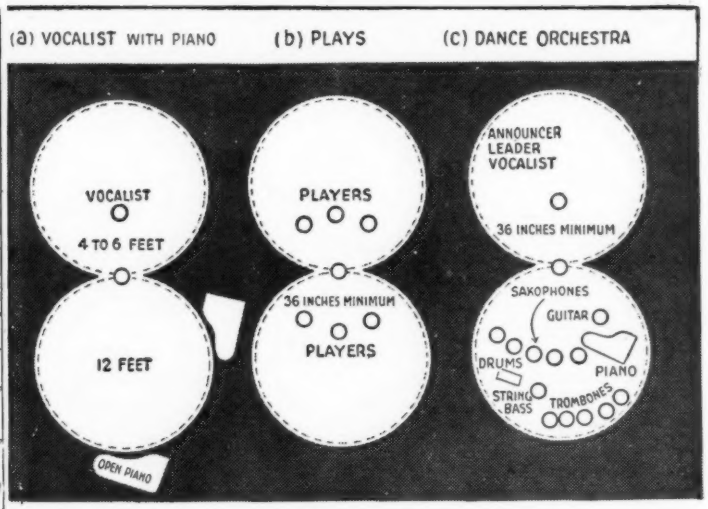


Fig. 1, left—Directional characteristic of velocity mike. Figures on side are degrees. Fig. 2, above—Set-up for vocalist with piano, players, or for orchestra and vocalist.

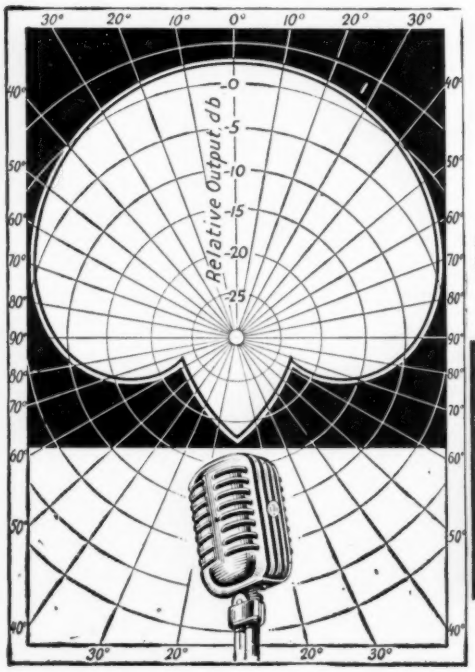
PLACING THE MIKE IN SOUND STUDIOS

By DON C. HOEFLER

WE have seen that a subject of extreme importance in high-fidelity audio reproduction is that of providing favorable acoustic conditions at the studio or auditorium. Also worthy of equal consideration is the proper placement of microphones with respect to the program sources.

In broadcasting's younger years, it was commonly accepted procedure to use several microphones at various locations to pick up a program, particularly when working with large groups of performers. This seemed necessary at the time, due to the low sensitivity and inherently high noise level in the "telephone transmitters" of that era. However, it was found that the outputs of the microphones, when used simultaneously and fed into a common amplifier, were considerably distorted, due to phase differences in the sound waves arriving at the various microphones. Therefore, the advent of more sensitive and less noisy microphones naturally led to single-microphone techniques. In modern practice, the microphone is placed at such a distance from the group that it alone is usually able to provide the desired acoustic balance. Thus the practice of using several microphones simultaneously, with accompanying phase distortion, is avoided. Of course, when a certain desired emphasis can in no way be given a particular group when using a single microphone, it may become necessary to fade in one or more additional mikes at certain times. This is done only during the time interval that the prominence is desired, to stress a certain vocalist, instrumentalist, announcer, or sound-effect. Absolute control of the individual microphone circuits in this arrangement must be exercised by a competent engineer at the control-room mixing panel. Furthermore, extensive rehearsals and remote listening tests will usually be required to achieve the desired effects and proper balance of the several input circuits.

The volume ranges of various musical instruments denote their combination into several general groups, each instrument in a given group being placed approximately equidistant from the microphone. The first group usually contains the violins, violas, and



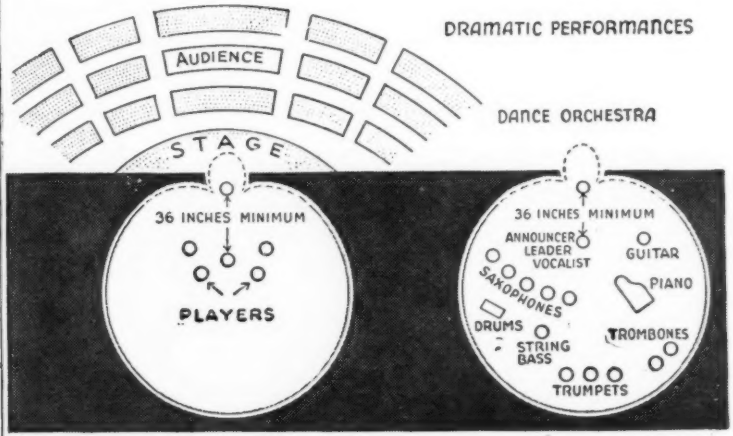


Fig. 3, left—The highly directional cardioid microphone, used in most stage installations. Fig. 4, above—How its directional characteristics are used in theatres and dance halls.

cellos; the second group, the piano, harp, clarinets, and flutes; the third group, the oboes, bassoons, English horns, and (French) horns; the fourth group, the doublebass (string bass), tuba, and percussion section; the fifth group, the trumpets and trombones. In dance bands, the guitar is in the first group, the saxophones in the second or third, and the banjo in the fourth.

The directivity characteristic of the velocity or ribbon microphone is shown in Fig. 1. It is evident that this instrument is markedly directional, a property which is practically independent of the frequency. This is of considerable advantage in remote broadcast pick-ups and public-address locations, since extraneous sounds arriving from side directions will have little effect. Therefore, there is allowed more than a little improvement in balance, clarity, selectivity, and all-around naturalness. The speaker, vocalist, or musical instrument should not be placed closer to the microphone than 2 feet, and a distance of 3 or 4 feet is preferable. Neither should the microphone be placed closer than 3 feet from any solid reflecting surface. At shorter distances there is a tendency toward "boominess." At (a) of Fig. 2 is seen a common set-up used for a vocal soloist and piano accompanist. This arrangement permits the two performers to face each other, which allows for better coordination of timing and cuing. For any dramatic presentations, as shown at (b), the bi-directional characteristic may be used to its fullest advantage, as the actors may be grouped about the microphone at the proper distances and positions, and all have practically unlimited freedom of movement. The dance band set-up shown at (c) allows fine balance, and permits the principals to coordinate their actions to the part each has on the program. For example, the announcer, band leader, and vocalist, all may take the position before the microphone and facing the orchestra, at the various times each of their particular parts may be called for. In public-address applications, this microphone may usually be placed within 3 or 4 feet of the speaker, but it is imperative that the direction of minimum sensitivity is toward the loud-speaker system.

In many studio and public-address applications, it is desirable to eliminate the pick-up of unwanted sound in the rear of the microphone, such as crowd noise or reverberation roar and echo. The "cardioid" or unidirectional velocity microphone is very useful for such purposes. As shown in Fig. 3, this instrument was designed to pick up sound arriving from one side only, while almost completely rejecting sound from the other side. The angle of useful pick-up is approximately 150 degrees. As with the bi-directional type, the source of sound should never be closer than 2 feet, with 3 or 4 feet preferred. Although this microphone may be used in many types of studio work, it is of particular advantage in the case of stage plays, auditorium studios, and in remote pickups at theaters, ballrooms, and night clubs, where crowd noises may present a serious problem. By placing the microphone with its "dead" side toward the audience, a 20-decibel discrimination will provide the desired attenuation of audience noise. Fig. 4 shows typical set-ups for plays and dance orchestras.

In the final analysis, the only satisfactory reproduction of sound is that which presents a pleasing effect to the human ear. Thus the sound engineer must give due consideration to the physiological process of hearing as well as the physical properties of the sounds being reproduced. Therefore, the final proof of the value of any microphone set-up lies in actual listening tests over a high-fidelity monitoring system, conducted by one who has a trained ear for music and experience in the determination of high-quality sound.

"Metered Sound"

Muted Megaphone Helps Fit Hearing Aids

TESTS for fitting hearing aids have been considerably simplified by a device described by Drs. Walter Hughson and Eva Thompson in a recent issue of the *Journal of the American Medical Association*. It is an ordinary acoustic megaphone, suitably muted by four felt disks, of such size that when placed in the megaphone they will be spaced at equal intervals along the flare.

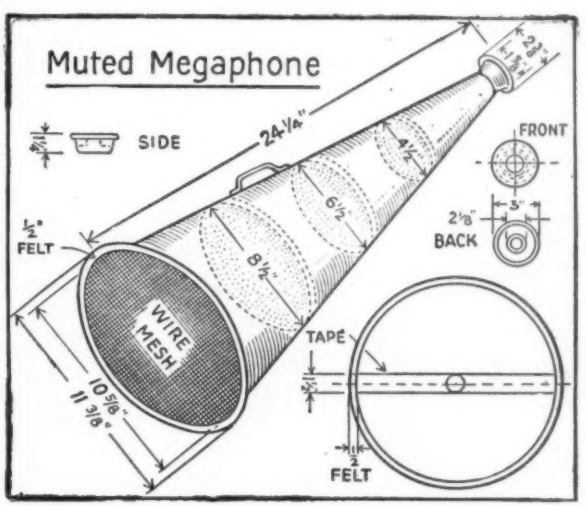
Apparatus for producing sound which can be accurately varied in volume is much rarer than accurate sound-measuring and analyzing equipment (though certainly no harder to design or manufacture). Especially is it likely to be lacking in the offices of the usual ear, eye, nose and throat specialist who is commonly responsible for prescribing and fitting the hearing aid.

Lacking correct apparatus, the practice is to test the patient by repeating words or sentences at progressively lower intensity levels, or moving farther from the patient and repeating them at the same level. This method may be grossly inaccurate. It is extremely difficult to control the voice to give various gradations of intensity, and when walking away from a patient there is an instinctive tendency to raise the voice. It has been found, however, that it is easy to maintain a relatively constant loudness for direct conversational speech.

The muted megaphone offers a technique which takes advantage of the constant volume tendency of the conversational voice. The person making the test talks in a normal tone, which is attenuated by placing one, two, three or four of the disks in the megaphone.

By careful and accurate acoustic measurement it has been found that at a distance 6 feet from the speaker normal conversational voice is amplified 20 decibels by the use of a 2 foot megaphone. If the megaphone is damped or "muted" by the placement of specially designed felt disks, the voice is attenuated or reduced from 10 to 15 decibels for each disk. With four disks in place the voice is attenuated to a level at which only the normal hearing person can understand the spoken words.

Conversational voice is from 40 to 50 decibels above the normal threshold. The unmuted megaphone increases it 20 decibels more or from 60 to 70 decibels above the normal threshold and an even greater increase may be obtained by shortening the distance between the megaphone and the patient which may be necessary in the case of the profoundly deafened individual. If each disk gives an attenuation of 10 to 15 decibels, the maximum attenuation of the four disks is approximately 50 decibels. Measurements have been made to determine whether there was frequency discrimination. This does not occur to any appreciable extent. In order to eliminate leakage of sound outside the megaphone a sponge rubber cushion is placed around the mouthpiece. The disks are constructed of one-half inch felt backed by wire mesh for support, with a knob in the center to facilitate placement and removal. Two strips of tape are placed lengthwise inside the megaphone to keep the felt disks in place.



The patient is seated in a chair 6 feet from the unmuted megaphone and asked to repeat the test sentences spoken by the examiner through the megaphone. The conversational voice is either attenuated by the placement of the felt disks inside the megaphone or made louder by shortening the distance between the megaphone and the patient, until a point is determined at which at least 60 per cent of the sentences can be repeated correctly. This distance is recorded and maintained throughout the rest of the test.

A hearing aid is then placed on the patient's ear, the type of aid and the ear on which it is used having been determined by previous audiometric tests. One or two of the smaller felt disks are placed in the megaphone, sentences again delivered to the patient and adjustment of the volume control of the hearing aid made.

According to the minimum requirements for acceptance by the Council on Physical Therapy of the American Medical Association, an electrical hearing aid shall improve at least 30 decibels for speech the hearing of the deafened ear for which it is prescribed or fitted. If the patient can understand speech with three disks in place the aid is supplying a completely adequate gain of more than 30 decibels. If speech is not intelligible with the three disks the aid is inadequate. Four disks in place would mean a gain of about 50 decibels and is the maximum any hearing aid can give without distortion. In most instances this amount of gain is not necessary.

This method should be used, of course, only when accurately controlled electrical equipment is not available.

TRANSMISSION LINES

By **M. N. BEITMAN***

THE increase in the use of higher radio frequencies for television, frequency modulation, and radio locator-detector apparatus is forcing radio servicemen to become acquainted with subjects previously considered outside the servicing field. *Transmission lines* is one such subject. Any electrical line which guides power between two points and has its physical (actual) length in the order of the electrical wave length being employed, is considered a transmission line. For complete understanding of the theory of transmission lines and their applications, a certain amount of college mathematics is essential. However, a good general idea of the behavior and uses of transmission lines can be obtained from this non-mathematical explanation.

Transmission lines are used mainly for coupling the antenna to a transmitter which may be located some distance away. Besides this primary application, lines are used as impedance matching devices (like transformers); in place of lumped series or parallel tuned circuits, as all types of filters; and for high frequency measurements. To understand how these functions are obtainable from lines which at lower frequencies (audio or 60-cycle power frequencies) are considered simply as conductors of electricity possessing only resistance, some new concepts must be introduced.

Even a straight short piece of wire has both capacitance and inductance. Focus your attention on a very tiny piece of the wire at one end and another tiny piece of this same wire a short distance away. Certainly these metal pieces (parts of the wire), as such, are separated by the wire between them which in turn may be considered as a resistor. This wire does have resistance and this *resistance* produces a voltage difference (drop) between the two tiny parts of the wire. The two tiny pieces of wire form also two plates of a condenser, with the surrounding air acting as the dielectric. No fixed quantity of air, or any special section of air, serves as the dielectric, but all air (and all other insulators in the universe for that matter) serve as the dielectric of this condenser which we have just described. In a similar fashion, all other tiny portions of our wire, form condensers with each other.

In a like manner, it can be shown that the magnetic field produced by any infinitesimally small portion of the wire, cuts other sections of the wire and the effects of self-inductance are present. We begin to see that any wire which may form a transmission line has, besides resistance, capacity and inductance. Also the leakage present may be expressed as conductance.

Let us connect two adjacent, parallel wires to a high frequency generator (a radio transmitter will do). In a practical experiment, these parallel wires (or line) could be made by mounting two lengths of copper wire on supporting insulators, so arranged that the wires would run parallel, perhaps two inches apart. The line could be coupled to the transmitter by being connected to a link coil placed near the final tank coil.

The electrical energy proceeds along the line at a definite rate. If our transmitter is producing a sine wave shaped voltage, as is the usual case, sine wave currents and voltages occur at all points along the line but with the actual instantaneous values at time displacements which depend on the distance from the generator.

The end of the line may reflect voltage and current waves. These may reinforce or reduce the original waves. In particular, if the line is an odd multiple of a quarter wave length (1/4, 3/4, 5/4 of a wave length) and is properly terminated for the purpose, the reflected energy will be in phase with the new forthcoming waves, and large standing waves will be developed. These standing voltage waves can be detected with a neon bulb, while the current standing waves can be observed with a pilot bulb connected to an exploring single turn loop. The voltage and current standing waves are 90 electrical degrees out of phase. See Fig. 1.

The fields produced by the two wires of a line oppose each other and very little radiation takes place. The main losses are the actual resistance losses of the conductors used. A resonant line, therefore, has small losses and a high Q. As the two wires of a resonant line are spread apart, radiation increases. Radiation resistance (losses of energy from the system because of radiation) also increases. Radiation can be prevented by using a coaxial cable. Such a cable may be flexible or solid and has one small wire conductor completely surrounded by (but insulated from) a conducting tube serving as the second conductor. The characteristics of coaxial cables depend primarily upon the ratio of the inside diameter of the pipe to the diameter of the center wire, and upon the dielectric.

If the line we used for our explanation were infinitely long (that is, continued without an end), there would be no reflection from the far end, since this end would never be reached. There would be no standing waves on the line for any frequency since there would be no reflection. In looking into the line, the generator would *see* a definite value of impedance which depends on the spacing of the conductors, size

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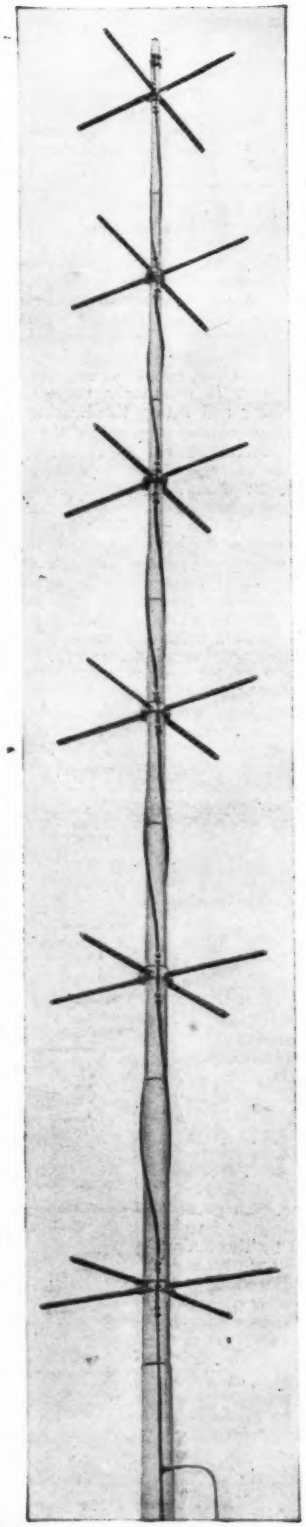

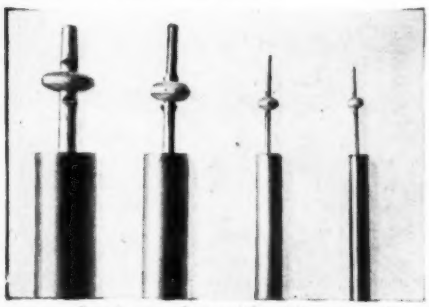

Specimens of co-axial cable, and a line of it on a turnstile antenna.

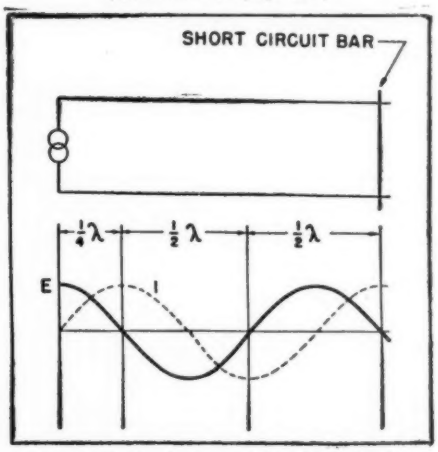

Fig. 1—A simple transmission line, showing the physical and electrical characteristics.

* Supreme Publications, Chicago.

STAGE-BY-STAGE TESTS

Your Signal Generator Will Help You Find Hidden Troubles

By JACK KING

THE signal generator is a useful tool. It can be employed for other purposes besides alignment of a receiver. In stage-by-stage testing it permits in many cases rapid diagnosis of the trouble. In Fig. 1 the diagram of a typical radio receiver is shown. Let's use the stage by stage technique in trouble shooting in this set.

First, by using the audio modulation signal of 400 cycles per second, we can test the audio section. We may connect two leads from the audio tip jacks on the generator to the two outside terminals of the volume control (R-26 in Fig. 1), with the receiver's volume control set at minimum. Now, if gain is brought up by advancing the control, the audio note should be heard. If it is loud and clear we know the audio stages are working properly. If the note is not heard the generator prods can be shifted to the grid of the 6K5 and ground. Should the signal now be heard, we might look for an open in condenser 28.

Let's assume that no signal was heard with the generator connected to the 6K5 grid and ground but that a signal does get through with the generator connected to the 6F6 grid and ground. We would suspect an open in C-34, or possibly some defect in the 6K5 stage, such as a bad 6K5, an open in its grid or plate circuit, or possibly a short circuit from grid to ground.

All of these conditions would be possibilities. In finding the trouble we would eliminate, in a step by step process of reasoning and testing, all of the possible causes of the trouble. For example, whether C-34 is open or not can readily be determined by shunting a new condenser across it and observing the results. Whether there is a short from grid to ground can be determined by inspecting the wiring and by using an ohmmeter. By indicating the defective stage or section of the set, the generator technique speeds up the work and you don't need to test every circuit with the volt-ohmmeter.

But suppose even the grid-ground connection in the 6F6 stage does not produce an audible response in the loud-speaker, what then? We may look for trouble in the 6F6, in the parts of the 6F6 stage, or possibly in the loud-speaker. Shifting the generator connection to the plate and ground in the 6F6 stage will show whether the speaker is working. If we hear a signal now, we know that the trouble lies between the 6F6 grid and the 6F6 plate. The lack of gain might be due to an open in the 6F6 grid circuit, a short from grid to ground, a weak emission 6F6 or possibly lower than normal heater, plate and screen voltages. A voltage test would quickly show the conditions in the 6F6 stage.

Because voltage measurements generally show the nature of the trouble quickly the signal generator technique is usually used only when there is some obscure or difficult condition to trace, such as distortion. However, the signal need not, necessarily, be furnished by a serviceman's signal generator. In a sense, a record player of the crystal pickup type is a generator, and such a record player is a handy thing to have around when checking for volume and distortion. The output of the record player can be fed to the two end terminals of the volume control (R-26) in a set such as this one, to provide an audio signal for checking purposes. If it is found that no distortion is heard when this is done, the trouble definitely is localized in some stage ahead of the audio input stage, which is a very useful bit of information to have.

The distortion is shown up in many cases by a changing of the note of the audio generator signal. It is somewhat easier to detect a change in a single frequency note than it is to detect a change in a composite signal such as the musical output signal of a record player or the music and voice modulated signal of a radio station. Therefore, we can check readily by shifting the generator connection along from grid to ground on each stage, being sure to use a blocking condenser to prevent disturbing any D.C. circuits. Unless the generator has larger than usual output, it may be found somewhat difficult to test the detector circuit by feeding in a signal to the plate and ground of the 6K7 I.F. stage. In many cases a weak

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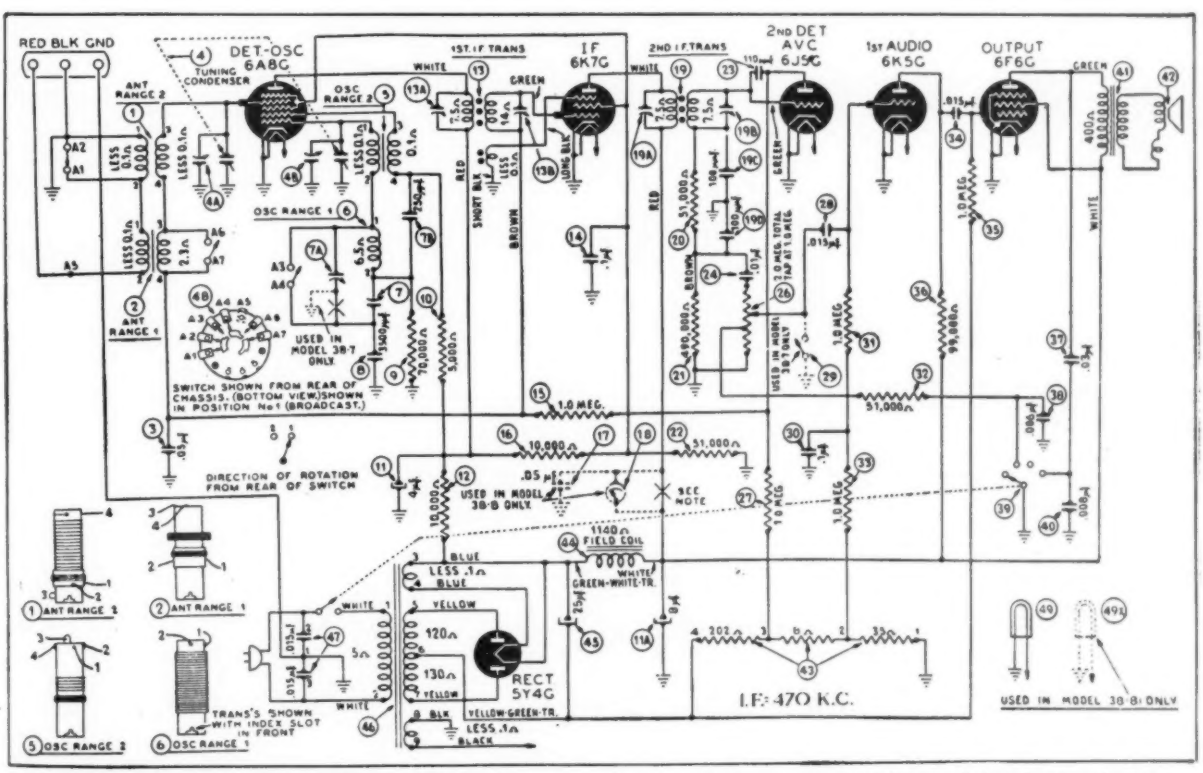

Fig. 1—The Philco 38-7, 38-8 and 38-9, a typical radio receiver shown here to demonstrate the technique of stage-by-stage testing.

ELECTRON POWER PACK

A Real D. C. Transformer with No Iron-Cored Parts

By DAVID GNESSIN

ALL radio and electronic equipment operates by virtue of the D.C. power furnished by the power-supply stage. Except in the case of dry-cell batteries, banked to provide the necessary voltage, or in the use of the greatly decreasing D.C. power lines, high-voltage D.C. can be provided only by rectifying A.C. or converting battery D.C. into A.C. by mechanical rotary or vibrating methods, then later rectifying in the usual manner.

We are concerned here with providing high-voltage D.C. from a secondary lead-acid or similar cell. To avoid using mechanical means of raising the voltage *(because of its large first cost and wear of moving parts)* we will have to raise it electronically. This brings up interesting considerations.

Direct current is unique. Except during the instant it is switched on or off, its flow through a transformer produces a steady magnetic field, which prevents the energy transfer required to raise the voltage. D.C. voltage may be reduced by dropping it through a suitable resistor, but it cannot be raised by merely passing it through something else. A.C. can be raised, but D.C. cannot.

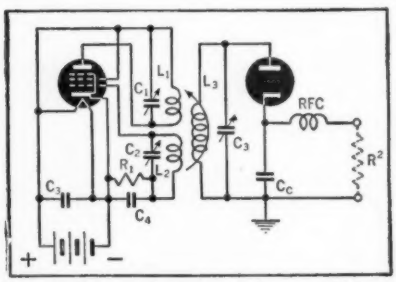

Fig. 1—This pack consists of an oscillator and a rectifier, and may have only one tube.

How, then, is it possible to operate a radio receiver on a farm with only the 32-volt D.C. farm battery, or an automotive radio-transmitter in a boat with its 12-volt marine battery, when the tubes in that equipment require voltages of 90 or more volts (D.C.)?

The answer is: A low-voltage power-oscillator is operated directly from the battery, providing high reactive voltages in its output, rectified to produce high voltage D.C.

Using a dual-purpose tube, such as the 25A7 shown in Fig. 1 (with its two sections separated into two halves of the tube envelope for ease in reading the diagram), with one section acting as oscillator and the other section as diode rectifier, the power-supply stage is made as simple as

(AUTHOR'S NOTE: Probably the only ELECTRONIC means of raising a low D.C. voltage to the high voltage D.C. necessary to operate electronic equipment is the POWER-OSCILLATOR/RECTIFIER method described herein. With not a single moving part it is a radical departure from the conservative methods of providing power-supply from a low D.C. source. Its analysis is described in detail.)

any other method, with the distinction of having no moving parts, ergo frictionless! With the possible exception of the archaic electrolytic interrupter this method has not been adapted for commercial use up to this time.

The primary source is a storage battery, shown in the diagram as a 24-volt lead-acid battery. This type was selected to best demonstrate the operation of the 25A7 tube. Batteries of other voltages may of course be used, if their voltage is equal to the filament voltage of the tubes utilized. For example, the 12B8 tube could be used with a 12-volt battery.

The battery supplies both "A" or filament voltage, and "B" or plate voltage, from the same positive and negative terminals. In the description following, the letters "A" or "B" will be utilized to designate filament or plate circuits, respectively, although it will be remembered the voltages are taken from the same battery in each case.

The heart of this power supply is the power-oscillator circuit. This is the left section of the tube shown in Fig. 1. Refer to it frequently when following the description. In this manner, its operation will be made very clear.

If you know what an electron does, and how it can create a magnetic field, follow the description carefully, with frequent glances at the diagram, and you'll have no difficulty in understanding how the circuit works, and why it does what it does.

When the filament is heated, the cathode —connected to the negative end of the B battery, evaporates electrons, which are drawn to the plate because of its positive charge (it is connected to the positive end of the B battery). Electrons go from the plate through L_1 back to the battery.

We can ignore the part played by the screen and suppressor grids. Though they are important, they are not necessary for the purposes of this explanation. The control grid *is* important in the action we are describing. It is connected (through L_2 and the grid-leak condenser combination R_1 and C_4) to the cathode, and hence is at the same voltage. But L_2 is closely coupled to L_1, through which a current is now flowing. As this current increases, a magnetic field is set up around L_1 and also L_2. Now watch what happens! A voltage is induced in L_2, whose windings are in such a direction that this voltage will make the grid end of the coil positive and the cathode end negative. But as the grid becomes more positive, electron flow through the tube increases, which increases the flow in L_1, the magnetic field around it, and consequently drives the grid still more positive!

Obviously the current through the tube cannot just keep on increasing. Several things, such as the limit to the cathode's ability to emit electrons, the increase in grid voltage toward the battery's limit, and the drop in plate voltage due to the increasing current bucking the impedance of coil L_1, put a limit to it. Thus the current through the tube and coil is soon at a maximum, and stops increasing. It cannot remain steady, though. Just as soon as it stops increasing, the voltage on the grid is no longer influenced by it. (Remember that only when a magnetic field around a coil is *increasing* or *decreasing* can it induce a voltage.) So the positive voltage on the grid begins to disappear as it starts to return to its original condition of equi-potential with the cathode.

As soon as the grid starts to become more negative, *less* current can flow through the tube. The magnetic field around the coils starts to *decrease*, and a voltage is induced in L_2 which causes the grid to become *more* negative. This continues till the current drops to zero, when of course there can be no magnetic field around the coils and no action on the grid, which by this time is far negative as compared to the cathode. As the piled-up electrons on the grid start to flow back to the cathode, the grid becomes more positive, and the whole cycle starts over again.

This is a condition of *steady oscillation*. Because the condenser-coil combination L_1-C_1 likes to charge and discharge at a definite frequency (a definite number of times a second), it is easiest for the tube to oscillate at that frequency. That is why we have C_1 as well as L_1. The grid-leak, R_1, is used to keep the grid at an average negative potential when the tube is oscillating. Every time the grid goes positive it gets a few electrons from the cathode—becomes a sort of plate, in other words. As these electrons flow off through R_1, the voltage drop gives the grid sufficient *bias* for best operation. C_1 is simply to let the rapid pulses (of radio-frequency) current around R_1, whose opposition to their flow might be great enough to stop oscillation.

Coil L_3 is also coupled closely to L_1. By means of its condenser C_5, it may be tuned to resonance with the oscillating circuit. Its impedance to the rapid alternating currents

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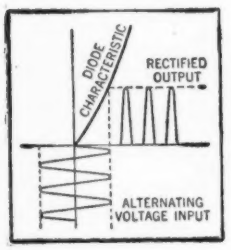
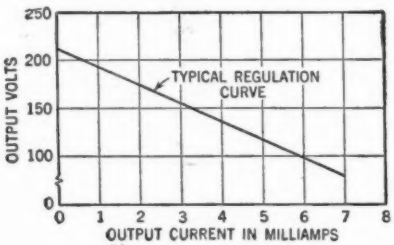


Fig. 2—Oscillator input to rectifier, and output before filtering. Fig. 3—The voltage supplied drops rapidly as the load is increased.



World-Wide Station List

Edited by ELMER R. FULLER

RADIO is following American soldiers of the Allied Expeditionary Forces as they move into Europe, with a service unlike anything ever attempted before in military history. The BBC has inaugurated the broadcast of many kinds of American and British program material to the troops on the continent. This set-up is under the joint supervision of radio personnel of the United States, Britain and Canada. News broadcasts are transmitted every hour, and are given priority over other types of program material. The schedule is for seventeen hours daily starting at 5:55 am, British time.

Following is the present schedule of the news broadcasts by the BBC. All times are Eastern War Time.

Time	Frequency	Call
6:00 to 6:02 am	11.68	GRG
7:00 to 7:15 am	11.68	GRG
9:00 to 9:10 am	15.31	GSP
11:00 to 11:15 am	15.31	GSP
12 noon to 12:15 pm	15.31	GSP
5:00 to 5:02 pm	11.68	GRG
5:45 to 5:50 pm	11.93	GVX
	9.58	GSC
5:59 to 6:00 pm	11.68	GRG
	2.69	GRX
	2.88	GRC
6:45 to 7:00 pm	11.93	GVX
	9.58	GSC
	9.69	GRX
	11.68	GRG
	2.88	GRC
9:00 to 9:10 pm	9.58	GSC
	6.11	GSL
	7.26	GSU
	9.69	GRX
	2.88	GRC
	6.01	GRB
10:00 to 10:01 pm	9.69	GRX
	2.88	GRC
	6.01	GRB
10:45 to 11:00 pm	9.58	GSC
	6.11	GSL
	7.26	GSU
	7.12	GRM
	2.88	GRC
	9.51	GSB
	6.15	GRW
12:30 to 12:45 am	9.58	GSC
	6.11	GSL
	7.26	GSU

The BBC gives a complete review of their programs daily at 10:15 am, 2 pm, 5:15 pm, and 10 pm. Also Sunday, Wednesday, and Friday at 8:15 pm; Monday, Tuesday, and Thursday at 8:20 pm; and on Saturday at 9:30 pm.

In the near future, the publishers of *Radio-Craft* will make an award of a Listen-Post Certificate to active observers who are sending in reports regularly. These are now being printed, and will be ready for mailing soon. We can still use monthly reports from a few more observers; so if you wish to become associated with us, please write.

If you dig up any information on any of the new Allied Nations radio stations in Europe, let us in on it. In this way we can get it to all of our readers and short-wave fans. Also remember that only through your reports can we keep our station list and schedules up to date. Due to conditions, we can keep in constant correspondence with only about half the total number of broadcast administrations in the world.

Mc.	Call	Location and Schedule
5.145	PMY	BANDOENG, NETHERLAND INDIES; heard at 8:45 pm.
5.900	LRS1	BUENOS AIRES, ARGENTINA.
5.985	XGOA	CHUNGKING, CHINA; 10 am to 1:45 pm.
6.025	AFHQ	ALLIED RADIO—ALGIERS; heard relaying "Voice of America" at 5 pm.
6.040	WRUW	BOSTON, MASSACHUSETTS; Central America beam, 9:30 pm to 2 am.
6.040	AFHQ	ALLIED RADIO—ALGIERS; 4 to 6 pm daily.
6.098	ZRK	CAPETOWN, SOUTH AFRICA; heard at 10:30 pm.
6.100	VPD2	SUVA, FIJI ISLANDS; 1.45 to 4:30 am.
6.165	HER3	BERNE, SWITZERLAND; 9:30 to 11 pm, except Saturdays.
6.190	——	ATHLONE, IRELAND.
6.990	XPSA	CHUNGKING, CHINA; 1:30 to 3:10 am; 7 am to noon.
7.171	XGOY	CHUNGKING, CHINA; East Asia and South Seas beam, 7:35 to 9:40 am; North American beam, 9:45 to 11:40 am; European beam, 11:45 am to 12:30 pm; East Asia and South Seas beam, 12:30 to 1:45 pm.
7.19	COCG	HAVANA, CUBA; heard in afternoons.
7.260	GSU	LONDON, ENGLAND; North American beam, 8:15 pm to 12:45 am.
9.100	ICA	NAPLES, ITALY; heard at 10:45 pm calling CBS.
9.520	——	COPENHAGEN, DENMARK; heard 8 to 11 pm; under German control.
9.540	VLG2	MELBOURNE, AUSTRALIA; 8:10 to 8:45 am.
9.646	XGOY	CHUNGKING, CHINA; East Asia and South Seas beam, 7:35 to 9:40 am; North America beam, 9:45 to 11:40 am; European beam, 11:45 am to 12:30 pm; East Asia and South Seas beam, 12:30 pm to 1:45 pm.
9.700	WRUS	BOSTON, MASSACHUSETTS; Central America beam, 7:30 pm to 2 am.
9.730	XGOA	CHUNGKING, CHINA; 1:30 to 2:40 am; 6:30 to 10 am.
9.855	KWIX	SAN FRANCISCO, CALIFORNIA; Australian beam, 1 to 8 am.
10.050	SUV	CAIRO, EGYPT; heard calling New York occasionally on Sundays.
11.000	PLP	BANDOENG, NETHERLAND INDIES.
11.040	CSW6	LISBON, PORTUGAL; Brazilian beam, 6:45 to 8:45 pm.
11.090	——	PONTA DEL GADA, AZORES; heard at 2:45 pm.
11.145	WCBN	NEW YORK CITY; European beam, 6 to 8 am.
11.145	WCDA	NEW YORK CITY; European beam, 5:15 to 7 pm.
11.410	——	"RADIO DAKAR," FRENCH WEST AFRICA; 3 to 5 pm.
11.500	VPLIO	BARBADOS, BRITISH WEST INDIES; heard testing on a Sunday afternoon.
11.535	DZA	BERLIN, GERMANY; afternoons.
11.600	——	ROUMANIAN FREEDOM STATION; 1:45 to 1:55 pm; 4:15 to 4:25 pm.
11.616	COK	HAVANA, CUBA; "The Voice of Liberty"; noon to midnight.
11.633	——	HUNGARIAN NATIONS RADIO; 1:15 to 1:27 pm; Sundays, 11:15 to 11:27 am.
11.65	COCX	HAVANA, CUBA.
11.68	GRG	LONDON, ENGLAND; 6 to 7 pm.
11.69	XGRS	SHANGHAI, CHINA; 11:15 am to 12:30 pm.
11.7	GBW	LONDON, ENGLAND.
11.7	HP5A	PANAMA CITY, PANAMA; evenings.
11.705	SBP	STOCKHOLM, SWEDEN; 2:45 to 3:10 am; 7 to 7:55 am; 11 am to 2:15 pm; 2:30 to 5:15 pm; 9 to 10 pm; Sundays only, 4 am to 2:15 pm.
11.705	CBFY	VERCHERES, CANADA; 11 am to noon.
11.71	VLG3	MELBOURNE, AUSTRALIA; Tahiti beam, in French, 1:55 am; British beam, 3 am.

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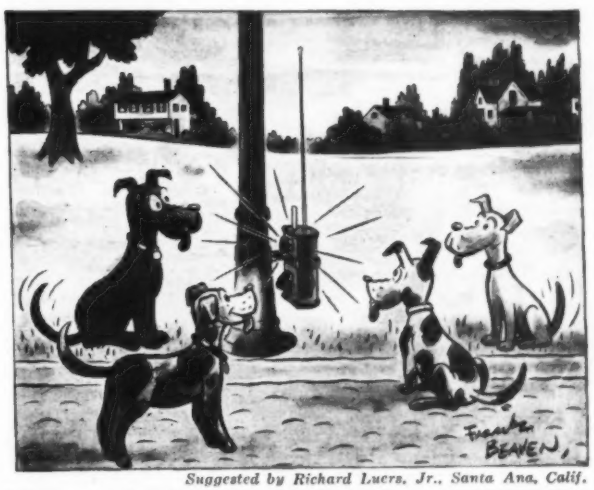


Suggested by Richard Luers, Jr., Santa Ana, Calif.

"Calling all dogs . . . calling all dogs . . . cat at the corner of Seventh and Oak . . . Hurry!"

Electronic Tube Symbols

Adherence to Fundamental Principles Prevents Costly Mistakes

By CARL E. WINTER

IN reading or drawing radio schematic wiring diagrams, the tendency to ignore the drawn symbol and to rely upon the written designation to explain the tube's function is very strongly manifested.

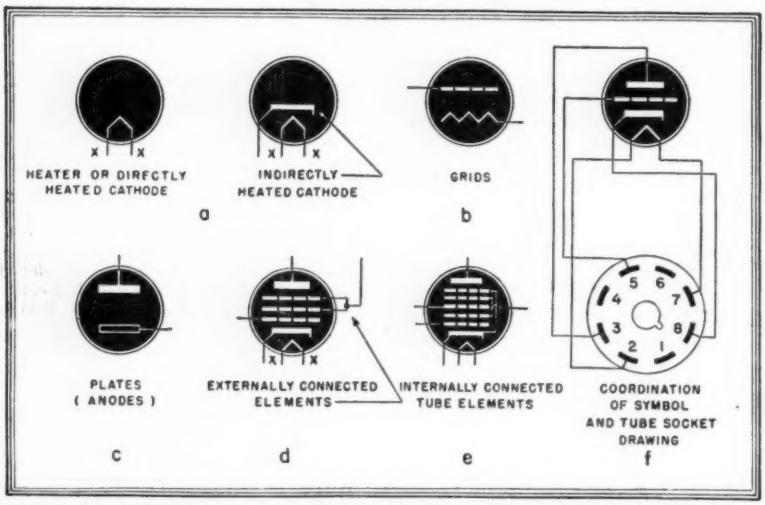


Fig. 1—Standard methods of showing internal elements in tubes, also a tube base diagram.

The reason for this is obvious. Many technicians and engineers lack the practice to fully interpret tube symbols and thus gain the greatest efficiency and speed in working with blueprints.

It is not always true that a tube symbol indicating a diode's function should be drawn as a diode. If the tube used is a 6Q7 and only the diode portion is used in the circuit application, the tube symbol must, none the less, be drawn representative of the 6Q7 tube.

If a tube possesses two plates for fullwave rectification and only one is used as shown by the schematic, the other cannot merely be left out of the symbol, it must be shown so that the engineer or technician can tell at a glance what type of tube is actually used and can quickly estimate its operating characteristics and circuit requirements. The unconnected elements of the tube should be terminated at the circle indicating the tube's envelope.

By adhering to this method of direct representation, the possibility of errors getting by all concerned is greatly reduced.

Careful use of tube symbols will also simplify the drawing of the necessary correlated tube socket, tube base, and wiring diagrams.

If, for example, a 6X5 rectifier is drawn as a diode and marked 6X5, the reader of a schematic can usually identify the tube as possessing two plates. But if, by some error the legend "6X5" is not shown or is accidentally written as "6Q7", the tube socket drawings, tube base diagrams and wiring diagrams may all be prepared for the 6Q7 tube's connections. Many headaches follow when eventually the error is discovered. If a tube symbol is drawn to represent a particular tube such confusion is reduced to a minimum.

Many tubes which have their elements internally connected are used in present day circuits. Similarly, only certain elements of other tubes are actually wired to circuit components. These are factors which must not be ignored in drawing schematics.

While it may not be essential to show unused elements and connections in a schematic they are definitely needed in wiring diagrams and tube socket drawings.

As in most things this principle of adhering too rigidly to graphical symbolism can be overdone. There are only a few basic types of tubes although the tubes of each type may run well into the hundreds. The basic types have generally recognized symbols to represent them and if these few are studied and known they will serve to reduce the major problems arising from tube symbolism in radio circuit diagrams.

The use of graphical tube symbols in actual wiring diagrams is not general practice. It is customary in this type of drawing to lay out pictorially the tube socket with its pin-indicating numerals and draw the wires leading to them.

In this pictorial work the possibility of confusion is very small. Wiring diagrams are usually used in conjunction with schematics and tube socket drawings.

Tube socket drawings picture the tube base itself with callouts to indicate which prongs are "hot" and which are not used.

The type of illustration shown in most tube manuals is not a true graphical symbol of the sort used in radio schematics. Rather, it serves to portray the elements of the tube in a simplified pictorial fashion and

(Continued on page 692)

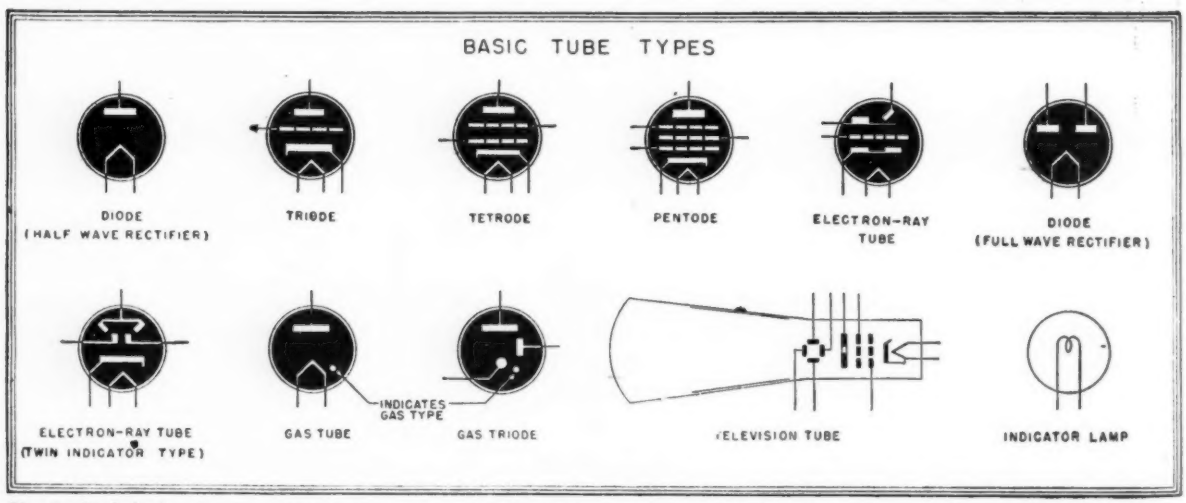


Fig. 2—Symbols for the commonest types of tubes. Slight modifications are needed for others. The cathode-ray tube is also shown.

 (Continued from page 668)

of the wire selected and the dielectric employed. This impedance is called the *surge* or characteristic impedance. Suppose we cut our line a short distance from the generator. (A few feet of wire removed from an infinitely long line, leaves the line still infinitely long.)

Looking into the infinite line remaining, the short line connected to the generator will see the characteristic impedance of this infinite line. See Fig. 2. Let us say that in this case the characteristic impedance is 100 ohms. If we replace the infinite line with a 100-ohm resistor, the short line connected to the generator will behave exactly the same and will not distinguish between a 100-ohm resistor, or a 100-ohm characteristic-impedance infinite line. In turn, the radio frequency generator connected to the input of our short line will see a 100-ohm impedance whether the line is infinite in length and has a 100-ohm characteristic impedance, or whether it is of finite size and is terminated in its characteristic impedance of 100 ohms, as in this case. This is indeed a simple way to increase the length of a line to infinity, and is of the greatest value in practical applications.

ANTENNA FEEDERS

A non-resonant parallel wire line radiates a negligible amount of energy and does not produce standing waves if it is terminated in its characteristic impedance. The effective voltage and current vary along an antenna, giving different impedance values between any two points along the antenna. A non-resonant line may have its two wires make contact to the antenna, a short distance on each side of the antenna center. By moving the contact points closer together or further apart, the impedance needed to match the line is obtained. Maximum power transfer will also occur when impedances are correctly matched.

A single wire transmission line may be used. In this case, the wire is connected to a point of correct impedance. This point is usually some distance away from the center of the antenna. The return circuit is completed through the antenna-to-ground capacitance. The proper adjustment of a non-resonant line can be checked by striving to obtain absence of current or voltage maximum points along the line. Fig. 3 shows several methods of connecting a transmission line to an antenna.

A line a quarter of a wave length long, connected to a radio frequency generator at one end and left open at the other end, will behave as a series resonant circuit. For example, using a frequency of 300 megacycles, which corresponds to a wave length of one meter, the line will be ¼ of a meter long. At and near this frequency this line will behave as a series circuit similar to one having a condenser and coil of values which would resonate at 300 MC. At frequencies considerably removed from resonance, the behavior of the line and the lumped constants resonant circuit will differ. In a like manner, a quarter wave length line short-circuited at the far end will behave as a parallel resonant circuit. Lines of a quarter wave length dimension are usually employed in practical circuits. Lines of longer physical length may be employed, but they produce larger losses, are bulky, and require more material.

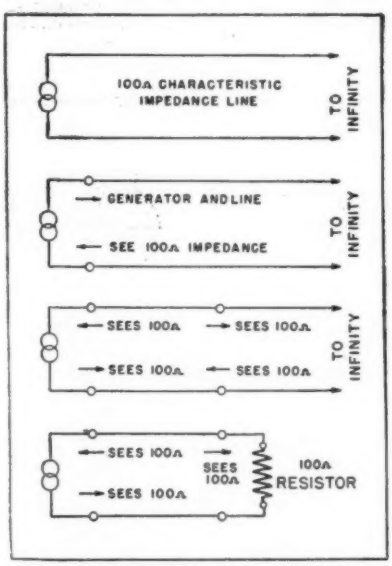


Fig. 2—Connecting the right resistor across it makes the short line seem infinitely long.

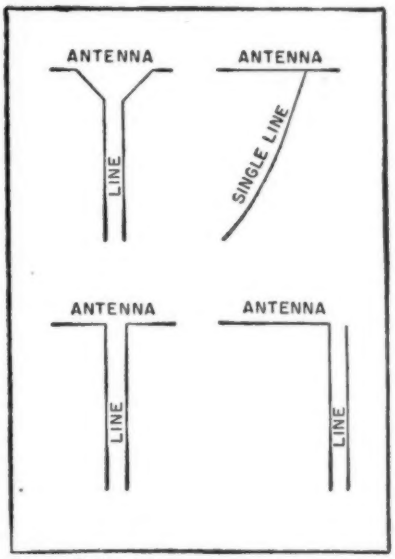


Fig. 3—Different types of antenna transmission lines. The Zeppelin is at lower right.

A short-circuited quarter wave length line is often used as the tank circuit of a high frequency transmitter. Such a line is easier to adjust than a circuit made up of a coil and condenser and, further, has a much higher Q (smaller losses) at the frequencies employed. The short circuit at the far end need not be made; in practice, a condenser of about .0005 mfd. may be used. This capacity serves as a practical short circuit for the R.F. employed.

At the short-circuited end, the current is maximum, since a direct path exists between the wires of the line; while the voltage is minimum (zero) because of the short. At the generator side these conditions are exactly reversed; the voltage is maximum and the current is minimum. See the illustration of the current and voltage distribution.

LINES AS TRANSFORMERS

The voltage varies along a short-circuited quarter-wavelength line, being maximum at the generator end and zero at the short circuit. The current variations are in reverse to the voltage changes. If the generator is left connected at one end, any voltage from maximum to zero may be obtained by placing a suitable resistive load at a suitable point along the line. This action corresponds to that of a step-down transformer.

Should the load be connected to the open end instead of the generator, while the generator is connected to some intermediate point of the short-circuited quarter wave length line, a voltage step up will result. Transformers which step voltages up and down also match impedances. This is a more useful application of the line.

Special short-circuited lines, known as stubs, may be used to tune out the unwanted reactive component of antennas or other elements, leaving only the resistive component to which power can be delivered at far greater efficiency. This is a very important application and is used extensively with antennas for high frequency work.

Radio servicemen are accustomed to visualizing radio filters as being made up of condensers and inductances. Since we now know that lines can be made to act as series and parallel circuits, they may be employed instead. Because lines have much smaller losses, they form filters with much sharper characteristics.

FOR MEASUREMENTS

It is very difficult to make tests and measurements at very high frequencies. Usually these measurements must be made indirectly or by means of a comparison. Because the physical dimensions of a transmission line are easily measured and because these dimensions are related to electrical properties such as frequency, impedance, etc., transmission lines serve a useful purpose for making measurements in the radio laboratory.

The value of an unknown high frequency can be determined by connecting the source of energy to a line and detecting the distance between successive voltage maximums. Under proper adjustments, this distance will be equal to one-half the wave length of the signal being considered.

●

A weekly experimental tele-toon series, a cross between the newspaper comic strip and the motion picture cartoon especially adapted for television, has been started on W6XYZ, Hollywood, Calif., owned and operated by Television Products, Inc. Character voices using off-stage microphones are synchronized with the camera focused on a screen where each pencil move of Frank Webb, cartoonist, is projected. Franklin Lacey and Shelly Mitchell portray the character voices.

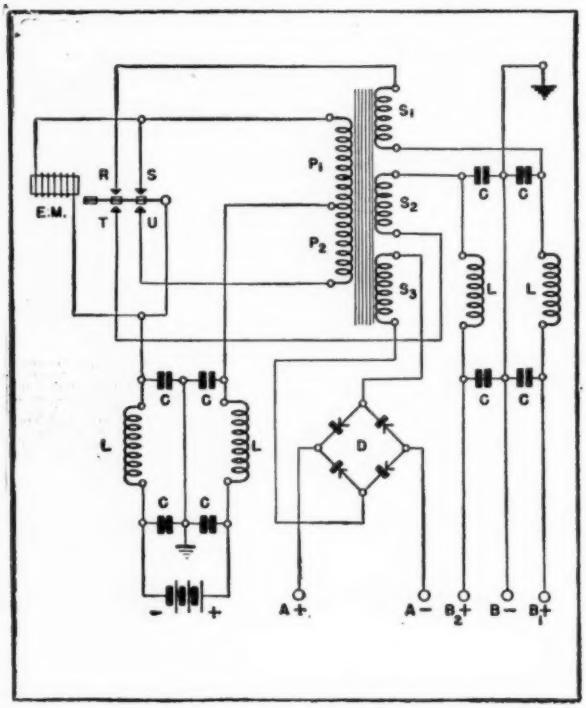
●

News, quiz shows, vaudeville documentary programs and other material of an impromptu nature made up most of the program material when CBS resumed live telecast on May 5, Gilbert Seldes, CBS director of television told the Television Press Club of New York.

CBS, with the theory that the thing television does best is to bring to its audience the unpredicted event, has attempted to carry that unrehearsed, impromptu atmosphere into their studio presentations, Seldes stated.

PROGRESS IN INVENTION

Conducted by I. QUEEN



TWO VOLTAGES FROM ONE VIBRATOR

Patent No. 2,347,165

A DEVICE to produce two different high voltages from one synchronous type vibrator has been patented by R. J. Aust, of Indianapolis, Ind., and assigned to P. R. Mallory and Co. It may thus be used to supply plate voltage and screen voltage without the inconvenience and power loss of a voltage divider.

The essentials are shown in the schematic. A 6-volt battery may be applied through a typical filter system. The vibrating reed is originally at rest on contacts T, U. Current therefore flows from the positive battery terminal through T, the electromagnet, P1 and back to the negative terminal. P1 is thus supplied with only a weak voltage.

The reed is pulled away from T, U and it contacts R, S instead. This shorts out EM and applies the full battery voltage across P1, so that EMF's are induced in the secondary windings. Simultaneously, S1 is connected through contact R across B1+ and B— (ground).

The electromagnet having been shorted out, the reed falls back on T, U, and the full battery voltage is now applied across P2 with current now flowing in the *opposite* direction through the primary. Again voltages are induced in the secondaries, this time of *opposite* polarity. S1 is disconnected from the external terminals, however, so that this reversed EMF is not present at B1—. The latter thus only shows *rectified* voltage which may be filtered as shown.

During this moment, also, S2 is connected through T to the terminals B2+ and B—, so that this voltage (of different magnitude than the first) is available. The cycle as outlined above then repeats.

A third secondary S3, of low voltage, is rectified by D and led to the A terminals, where it is available for filament lighting of D.C. tubes.

This circuit presents two advantages over conventional vibrator power packs. Possibly most important is the fact that the filaments of the tubes—of whatever voltage—may be directly supplied from the vibrator transformer. It is unimportant whether they are of the A.C. or D.C. type. Second is the opportunity of obtaining two separate B voltages; with, of course, the possibility of combining them should that be expedient. These features might be useless in many standard applications (as where a 6-volt battery is used with a device employing 6-volt-filament tubes) but in special applications might prove extremely useful. It would also have application for special arrangements such as a power supply for a receiver and a separate supply for a transmitter to facilitate break-in use.

REMOTE MOTOR CONTROL

Patent No. 2,345,778

THIS is a device invented by J. A. Van Lammeren of Eindhoven, Netherlands, to control automatically more than one function of a radio receiver.

The two major adjustments made on a radio receiver are the tuning adjustment and the volume adjustment. In sets to be operated at a distance it is usual to make use of a remotely controlled motor to perform the tuning adjustment. Volume control is had at the receiver itself, or by means of another long lead.

The present invention uses only one motor to accomplish both adjustments. As noted in the illustration, the shaft is movable axially. In the position shown, the volume control is being engaged by means of gears 4 and 6. If the shaft is displaced to the right, however, the tuning condenser would be engaged through gears 5 and 8. Note that for the latter engagement, contacts 10 and 11 close, shorting out the speaker during tuning.

Energization of the motor may take place by two different means. One is direct, so that the armature is drawn into the motor and the tuning condensers are rotated. The other means involves energizing the relay 12 shown in the figure. In this case the armature 13 is attracted, lever 14 drops into the guide 15 and simultaneously the motor is electrically connected by the closing of contacts 16 and 17. With this means of control, the lever 14 opposes the tendency of the shaft to be displaced to the right and tuning may be done.

The motor field has two distinct windings, either of which may be thrown into the circuit by proper push-button operation. Thus, the motor is reversible and may rotate in either direction.

IMPROVED ELECTRON LENS

Patent No. 2,347,982

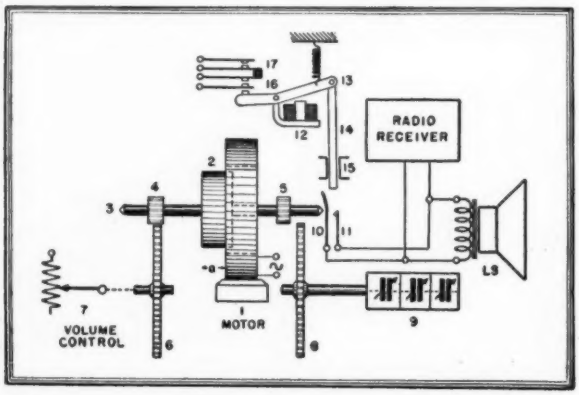
THIS device is an invention of Charles H. Bachman of GE suitcase electron microscope fame. It is designed to minimize the possibility of voltage breakdown between different elements.

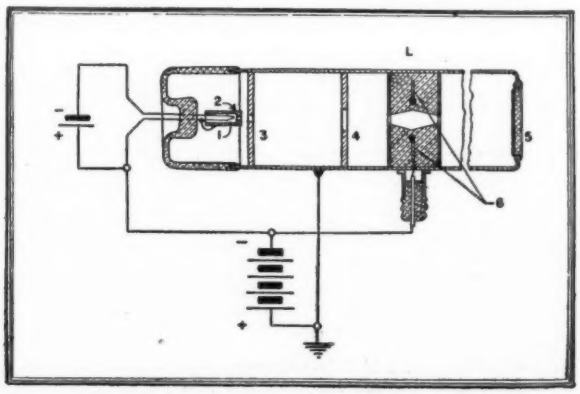
In Fig. 1 we have a cathode 1 surrounded by an apertured element 2 through which a narrow electronic beam moves. Element 3 is at a high positive potential compared with the cathode and accelerates the electrons. The object to be investigated is at the center of the screen 4, along the microscope axis.

The lens system L is shown composed of solid material except for an appropriately shaped opening to influence the electronic beam which then passes on and strikes the fluorescent screen 5.

In the ordinary electron microscope, a possibility of voltage breakdown exists between the

(Continued on page 689)





SPRAGUE TRADING POST

A FREE Buy-Exchange-Sell Service for Radio Men

ASK FOR THEM BY NAME

If you appreciate the Trading Post Advertising Service — and hundreds of servicemen have told us that they do—we know we can count on you to ask for Sprague Atom midget dry electrolytic capacitors by name, and to insist on getting them whenever they are available. Atoms are smaller, less costly, and are fully as reliable as the big, old-fashioned condensers they replace. Use them universally on all of your jobs. They're more dependable—they speed up your work!

FOR SALE—Precision No. 915 tube checker, new; Philco all-wave sig. generator; Philco 025 voltohmmeter; Rider's 1 through 7; coil winder; Green-Flyer turntable; Philco 40-516 radio-phono cabinet; "A" eliminator; 5" PM speakers in quantity; Weston 697 voltohmmeter; following tubes in quantities, std. brands, boxed, 50 to 200 of ea. type: 38, 39, 78, 84, 41, 42, 26, 5Y4G, 12I5, 6J5, 6L6, 6D6, 6C6, 30, 34, 6LA, AAA. Radio, 146-13 Northern Blvd., Flushing, L. I., N. Y.

WANTED—Good, serviceable V-O-M of popular make, and a-c test oscillator. Cash. R. M. Jurden, 309 Clinton St., Newark, O.

FOR SALE—New Thordarson transformers: 19P65; 19C45; 19C37; 65A73; 15R07; 67D50; 19M13; 19M14; 84D59; Stancor P3025; P5002; P5014; Kenyon T517; T153. Also one mobile 2½ meter xmitter compl. with tubes; one 832 xmitter complete for 2½ meters; 815 ditto; National NC-200 receiver like new. M. A. Twilley, 505 Riverside Drive, Essex 21, Md.

FOR SALE—Superior 1240 tube checker, and Supreme 385 automatic analyzer and tube checker, both 60 cycle. Geo. A. East, Forest Radio & Appl. Service, 148-150 Forest Ave., Buffalo, N. Y.

WILL SWAP Rider's Voltohmyst No. 20A slightly used. Will pay diff. on RCA MI 2701 recorder or equivalent. Grand Radio Service, Devils Lake, N. D.

FOR SALE—Portable Simpson multitester and tube tester model 440. Glenn Chenowith, 909 E. Oklahoma Ave., Tonkawa, Okla.

FOR SALE—Howard No. 436 Pre-amp.-650 with 4 loops, in A-1 condition, $90. Clark Ross, Box 211, Ogden, Utah.

FOR SALE OR TRADE—Speed-O-Print mimeograph machine with 5 reams paper, stencil paper, brush, pads, ink, etc., $25. Will trade plus cash for record changer; recorder; high-imp. velocity mike, Hickok 510X tube tester, sig. gen.; capacity tester, or what have you? F. U. Dillon, 1200 N. Olive Drive, Hollywood 46, Calif.

WANTED—One 1000 muf. var. condenser, preferably Cardwell X.B. 1000 H.S. or National E.M.C.-1000X. Frank T. Rootes, Ste. 2 Barnhart Apts., Calgary, Alberta, Canada.

FOR SALE—Precision dynamic Electronometer counter tube tester, No. 915. Used, but A-1 condition. Rodgers Appliance Shop, 210 W. Broadway, Red Lion, Pa.

WANTED FOR CASH—Sig. generator in A-1 condition, also all kinds of tubes. Harold's Radio Shop, 320 S.W. Court St., Pendleton, Ore.

SWAP OR SELL—American Trans. "bullet" mike. Will swap for late tube tester or sig. generator. Also have few hard-to-get tubes and 12" RCA speaker. Arthur E. Kelly, 3 Nira Ave., Jamaica Plain 30, Mass.

WANTED—Will pay cash (American money) for good V-O-M. Describe fully. John S. McKnight, Box 335, Niagara-on-the-Lake, Ont., Canada.

WANTED—913 cathode ray tube; I.F. xtal 456 kc.; 0-1 ma. meters; B.F.O. xformer; pair head phones. Gene Lesko, P. O. Box 510, Briston, Pa.

WANTED—A V-T-V-M; oscilloscope, 3"; large floor cabinet for 10" speaker; and vertical recordings (transcriptions) of semi-classical and classical music, 33-1/3 r.p.m. Pfc. Henry M. Hoffard, 1605 S.Y., Chicago V-Mail station; 732 W. Van Buren St., Chicago 7, Ill.

WANTED—Hallicrafter's Sky Traveler or Echophone EC-1. Cash. Pvt. A. Rutkovsky, Co. B, 1260 Eng. (C) Bn., Camp Pickett, Virginia.

WANTED FOR CASH — Any quantity of 50L6; 12SA7; 12SK7; 12SQ7; 1A7; 1H7; 35L6; 35Z5; 1N5; 58; 80. Also want parts & eqpt. Send list. Home Radio Service, 2118 Burt St., Omaha, Nebr.

FOR SALE—Tubes. Any voltage, any type. New—in sealed cartons. What do you need? Edw. H. Mohl, 5940 Windsor Ave., Philadelphia 43, Pa.

NEEDED AT ONCE—Battery operated sig. generator, Readrite 557 or similar, and Supreme diagnometer. Harold F. Houtz, 1305 Maple St., Dallas, Oregon.

FOR SALE—Variety of parts from dismantled police xmitter, incl. meters, high-voltage filter condensers, welded transmitter frame, DC genemotors, transformers, etc. Write for list. Radio Division, Police Dept. Highland Park 3, Mich.

FOR SALE—Raytheon BH 125 Ma. tube, $2.75. Johnson Radio Service, 302 Oakwood St., Austin, Minn.

WANTED — Hallicrafter's S-27 FM-AM receiver or S-31 FM-AM tuner with or without an amplifier. Have two Cinaudagraph LM 10-10 speakers for sale or trade. A. C. Brooks, 70 Gibbs Ave., Newport, Rhode Island.

WANTED—Sig. generator such as Radio City 703, Supreme 571 or equivalent. Robert Klinge, Route 1, Woodstock, Ill.

WANTED—Comm. receiver in good working condition for instruction of military personnel. E. W. Bedwell, RM1/C RFD No. 1, Box 221-A, Norfolk, Va.

WANTED FOR CASH — Clough-Brengle oscilloscope diagrams or instructions on models OMA or CRA. Vin Taberna, 16 Innis St., Port Richmond, N. Y.

WANTED—Good late tube tester, also a voltohmmeter or multi-tester. Jas. R. Casaday, 304 Wasp St., North Charleston, South Carolina.

WANTED—One 50L6GT and 25L6G or 25L6GT tube. Hillie's Radio Service, 9710 Mt. Auburn, Cleveland 4, Ohio.

FOR SALE—New 15-watt Webster Racine amplifier to use with Natl. Elec. Hawaiian & std. guitars; 2-6L6 tubes; 3-6N7; 1-5V4G; has 4 inputs, 1 for mike, 3 for guitars or phono. 75 DB. Neat carrying case. Heavy duty speaker. Cost $116. W. P. Houghton, 3029A Rutger St., St. Louis 4, Missouri.

WANTED FOR CASH — Sig. generator, preferably A.C., any make or model. T. R. Beaver, Killarney, W. Va.

FOR SALE—Portable Webster No. 42 P.A. system, carbon mike, & carrying case for complete unit. Speaker has 25' ext. Perfect condition. $25. V. E. Beck, 542 No. I St., Fremont, Nebr.

IMPORTANT NOTICE!

We discourage offers to buy or sell anything beyond the O.P.A. ceiling prices, and will not knowingly accept such ads for the Sprague Trading Post.

WANTED—PR-15 receiver in A-1 condition. S/Sgt. James L. Webb, 2109 Washington Ave., St. Joseph 43, Mo.

FOR SALE—Slightly used Triplett 0-100 microamperes meter No. 321. $10. W. B. March, 324 N. 4th St., Albuquerque, New Mexico.

WILL TRADE a Hallicrafters' Sky Buddy used less than 50 hrs. for a tube tester of good make to test all tubes. Adrian Chappelear, 17 Elder Place, Indian Head, Md.

FOR SALE—Hearing aid in perfect condition; also 4 auto radios; and one 955 acorn tube. Taubers Radio Shop, 516 So. Cicero Ave., Chicago, Ill.

FOR SALE—Supreme 85 port. tube tester; Dayrad 381 K port. tube tester. Both in excellent cond. C. F. Rogers, 1405 Washington St., N.E. Minneapolis, Minn.

WANTED — Phono recorder, also crystal mike. Cash. Robt. Daniels, 3704 E 5th St., Spokane, Wash.

TUBES FOR SALE—Few each, unused, mostly in sealed cartons, 30% off list: 2A6; 48; 6A4/LA; 6A6; 6B7; 6SH7GT; 7V7; 12A; 37; 59; 2A3H. Ralph Hunter, 12 North Street, Catskill, N. Y.

WANTED—Hallicrafter S-20R Sky Champion or S-19 Sky Buddy comm. receiver. Must be A-1 cond. A. R. Green, 3921 Hampshire Blvd., Fort Worth 3, Texas.

SWAP—16-tube '38 model Midwest chassis, all tubes, no speaker or tuning condenser; Philco 116 compl., needs minor repair; 50 81 tubes, etc.; W. E. Visatron; RCA photocells, used speakers, heavy chokes, trans., I-F coils, R-F coils, phone relay, enameled copper wire; 5-gang heavy tuning condenser; 6-400v 8 mfd. Dub. large condensers, etc. Want photo eqpt. or good cameras, or what have you? Edgar D. Growden, 818 Gephart Drive, Cumberland, Md.

FOR SALE—S-11 Hallicrafter Super Skyrider with crystal, 11 tubes, 15-watt audio output, in good condition, without speaker. $65. Max Shulsinger, 1205 E. 59th St., Kansas City, Mo.

FOR SALE—Stancor P-10 xmitter compl., $25; 3" Dumont oscillograph Type 164, $60; Green Flyer dual speed recording turntable, $18; RCA recording & playback unit with mike, $179.50; also 300 tubes all kinds 1.5v to 117v; also output transformers & power; one converter 6v to 225v D.C. Many other items. Write for list. Bernard Williams, 716 Union St., Coffeyville, Kans.

WANTED—Hickok No. 180x sig. generator. Cash. Chas. F. Kolb, 150 N. 52nd St., Philadelphia, Pa.

WANTED—Sprague Master Radio Interference Analyzer John Bennett, Uncasville, Conn.

FOR SALE—New and used tubes, all good, for list and 50% off. Write for list or state what you need. FM7 plus peak preselector plus noise limiter one unit all commercial, 80-40-20 coils, homemade pack, $30; Triplett signal generator, $10. F. K. Stevens, 17 Plant Court, Jamaica Plain 30, Mass.

FOR SALE — Hallicrafters SX-23 less speaker, but with tubes & crystal. Used only few days. No. 2 Rider's manual, early edition, $5; Utah power transformer No. 2292, Utah choke No. 4001, ditto No. 4667, Utah output transformer No. 8448 and Utah potentiometer No. PW 20m ohms. Kubit Radio Service, 119 Laurel St., LaPorte, Indiana.

SWAP — Factory reconditioned Clough-Brengle OMA sig. generator in brand new condition with all charts and instructions. Will trade even for any of following: Record changer; Aerovox L-C checker or C-R bridge; electronic voltmeter; or what have you? H. Lipson, Border Patrol, Box 271, New Orleans, La.

WANTED—One or two Weston or Jewell type 444 analyzers. Condition not too important as long as meters and electrical parts are in fair order. T. W. Mazza, 1711 Poplar Grove St., Baltimore 16, Md.

YOUR OWN AD RUN FREE!

This is Sprague's special wartime advertising service to help radio men get needed parts and equipment, or dispose of radio materials they do not need. Send your ad today. Write PLAINLY—hold it to 40 words or less. Due to the large number received, ads may be delayed a month or two, but will be published as rapidly as possible. Remember that "Equipment for Sale" ads bring best results.

Different Trading Post ads appear monthly in Radio Retailing-Today, Radio Service-Dealer, Service, Radio News, and Radio-Craft. Sprague reserves the right to reject ads which do not fit in with the spirit of this service.

HARRY KALKER, Sales Manager.

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Obviously, Sprague cannot assume any responsibility, or guarantee goods, services, etc., which might be exchanged through the above advertisements.

New Radio-Electronic Devices

OIL-FILLED CAPACITORS

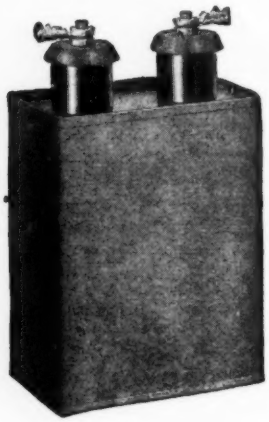
The Capacitron Co.
Chicago, Illinois

A NEW and complete line of rectangular oil-type capacitors, Type BCR, has recently been announced. Beside the BCR, capacitors are available in the cylindrical can type.

Made in standard container sizes and in voltage ratings up to 6000 V.D.C.W., these new Capacitrons will meet Army and Navy specifications, including total salt-water submersion tests.

These capacitors may be used as replacements for electrolytics in the lower voltage ranges, and in circuits designed for their own characteristics in the higher voltage and square can types.

Capacitron Bulletin 104 lists all pertinent data including capacities, voltage ratings, container sizes, types of terminals, and mounting arrangements.—*Radio-Craft*



RHOMBIC ANTENNA TRANSFORMER

The Andrew Co.
Chicago, Illinois

A NEW antenna transformer unit to couple an unbalanced 70-ohm coaxial cable transmission line to the 700-ohm terminals of a rhombic receiving antenna (or to any antenna terminal stub of 700-ohm impedance) is announced. The efficiency of the equipment holds losses down to less than 1 decibel over a frequency range of from 4 to 22 megacycles.

The transformer unit is designed for out-of-doors installation as close to the antenna terminals as possible; and it is housed entirely within a weatherproof cabinet with a water-tight cover. The waterproof housings and internal insulation of the transformer prevents the entrance of deleterious moisture, thus keeping efficiency high.

Circuit design of the transformer unit provides for the distinct advantage of simple D.C. continuity checking throughout the whole length of the antenna from the coaxial cable input terminal position, thereby facilitating antenna inspection and maintenance. The unusually broad frequency response is achieved by close coupling and by powdered iron transformer cores of high permeability. —*Radio-Craft*

PORTABLE RECORDER

Fairchild Camera and Instrument Corp.
Jamaica, N. Y.

THE Fairchild recorder is designed for portable field service, meeting requirements of direct lateral recording and reproducing of sound from 78 R.P.M. or 33.3 R.P.M. disc up to 16 inches. The equipment is extremely flexible, usable either indoors or outdoors, and can be set up in a few minutes with its easily-attached plug-in connectors.

The recorder mechanism has a selection of four cutting pitches; either from the inside of the record to the outside or from the outside in, without the necessity of changing feed screws. The turntable speed is changed from 78 R.P.M. to 33.3 R.P.M. by shifting a push rod on the center pivot of the turntable. Records may be put on and taken off without the necessity of removing any obstructing mechanisms. Equipment is supplied for operation on a 115 volt/60-cycle power line. The power consumption is 70 watts.

The unit now in production has a new magnetic cutter head replacing the old crystal cutter head; improved low-pressure pickup with a choice of crystal or dynamic type; and the weight of the machine has been lightened to 70 pounds.

The Fairchild Portable Recorder uses the Fairchild Crystal Pickup as standard equipment; it employs a piezo-electric crystal as the reproducing element and is solidly built of cast aluminum finished in telephone black and chromium. It is equipped with a permanent jeweled needle with a stylus pressure of approximately one ounce.

Available, at extra cost, is the Fairchild dynamic pickup, with frequency range from 30 to 10,000 cycles, and unusually low distortion content. This pickup is exceptionally well suited for dubbing as well as high quality playback.

The recorder is equipped with 110-120-volt 60-cycle synchronous motor which is dynamically balanced and selected for quiet operation. The entire motor assembly is suspended below the recorder panel on a cradle which "floats" independently of its associated equipment to isolate the motor vibration.—*Radio-Craft*

SAFETY DOOR INTERLOCK

General Electric Co.
Schenectady, N. Y.

A NEW door interlock switch is designed as an emergency device to interrupt control circuits where doors giving access to equipment are opened when the power is on.

It has a carrying capacity of 10 amp., 110 or 220 volts A.C. or D.C., and an emergency opening capacity of A.C. 7½ amp., 110 or 220 volts; D.C. on low inductive circuits, 5 amp., 125 volts; 2½ amp., 250 volts.

Application covers a wide range where doors, windows or covers must be interlocked for the protection of the equipment and safety of the personnel, for example, doors on radio transmitters, X-ray and therapeutic machines, intrusion-preventing devices or burglar alarms, and signal controls for fire doors.—*Radio-Craft*

DOUBLE CONNECTION PLUG

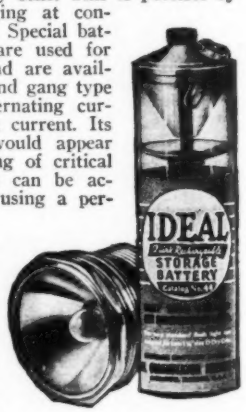
James Millen Mfg. Co., Inc.
Malden, Mass.

THE 372 112 Plug is compact and easy to use. Made in black and red regular bakelite as well as low loss brown mica filled bakelite for R. F. uses. Small circular depression on top for "color coding" or polarity indication. Designed primarily for use with the Millen No. 37222 captive head posts and No. 37202 plates.—*Radio-Craft*

RECHARGEABLE BATTERY

Ideal Commutator Dresser Co.
Sycamore, Illinois

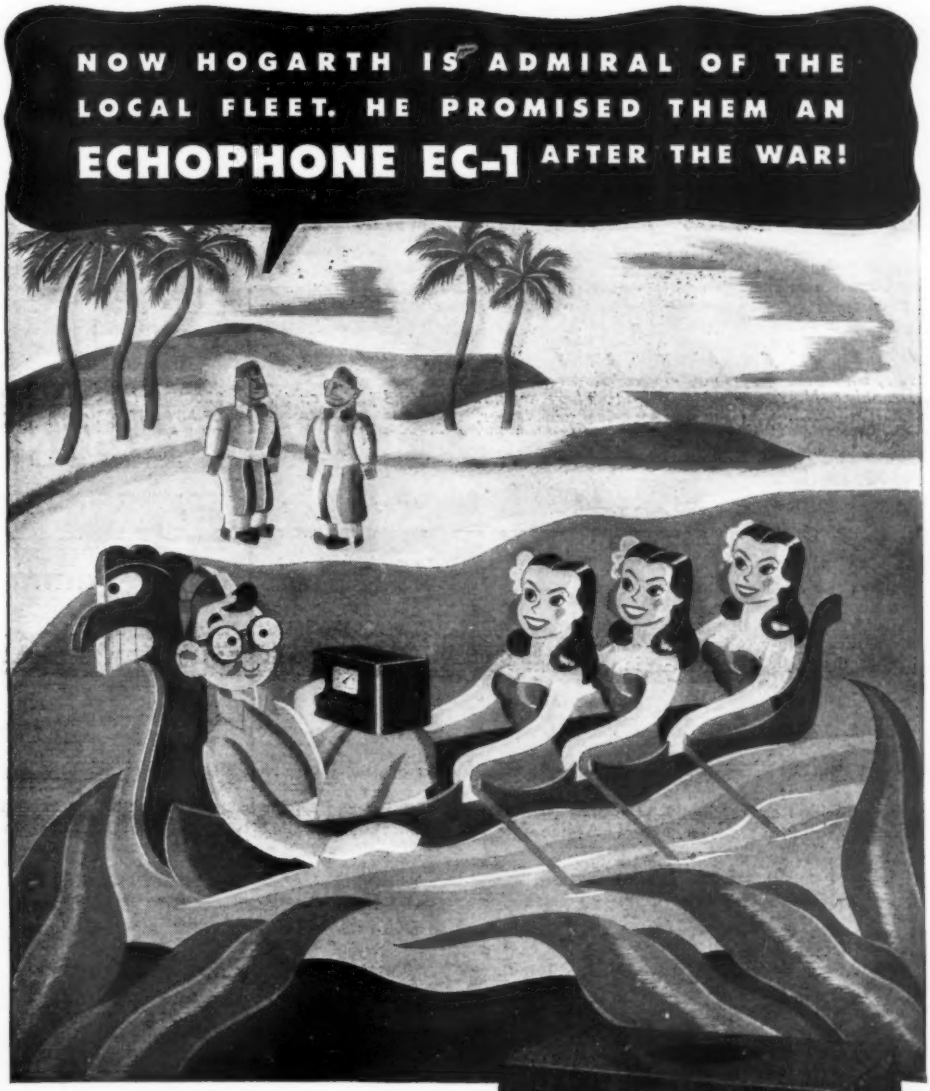
ACCORDING to the manufacturer, each of these batteries can replace up to 400 or more dry cells. This is possible by merely recharging at convenient periods. Special battery chargers are used for this purpose and are available in single and gang type —both for alternating current and direct current. Its timely value would appear to be the saving of critical material which can be accomplished by using a permanent unit in place of an "expendable" one.



The IDEAL Battery saves critical material—one battery replacing approximately seventy - five pounds of zinc, carbon and other materials. It has been generally distributed for casual use but under present conditions must be sold on priority. Regular recharging insures a bright, dependable light.—*Radio-Craft*

●

Five French-language broadcast stations across Canada are planned, if applications made to the Canadian government for licenses are granted. One of these stations is to be in Montreal, one in Manitoba, two in Saskatchewan and one in Alberta. These will be the first Canadian French-language stations to operate outside the Province of Quebec.



ECHOPHONE MODEL EC-1

(Illustrated) a compact communications receiver with every necessary feature for good reception. Covers from 550 kc. to 30 mc. on 3 bands. Electrical bandspread on all bands. Six tubes. Self-contained speaker. 115-125 volts AC or DC.

ECHOPHONE RADIO CO., 540 NORTH MICHIGAN AVE., CHICAGO 11, ILLINOIS

THE QUESTION BOX

Conducted by MONROE M. FREEDMAN,
RADIO MECHANICS AND INDUSTRIAL DEPARTMENT, QUEENS VOCATIONAL HIGH SCHOOL

All queries should be accompanied by a fee of 50c to cover research involved. If a schematic or diagram is wanted, please send 75c, to cover circuits up to five tubes; over five tubes, $1.00.

Send the fullest possible details. Give names and MODEL NUMBERS. Include schematics whenever you have such. Serial numbers of radios are useless as a means of identification.

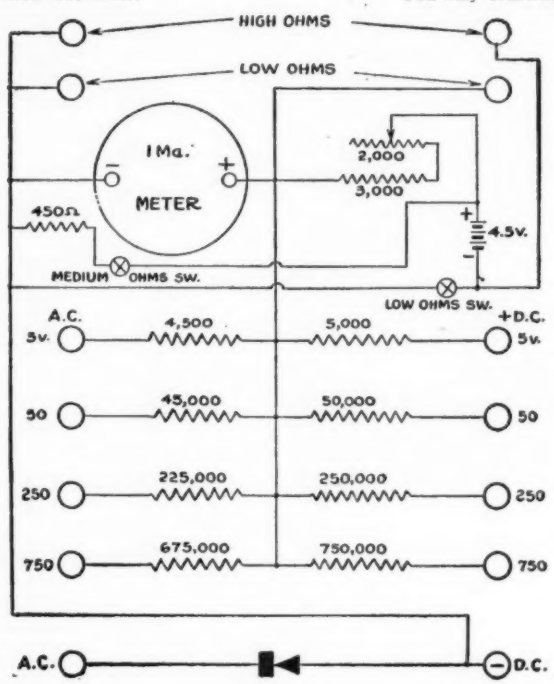
No picture diagrams can be supplied. Back issues: 1944, 25c each; 1943, 30c each; 1942, 35c each; 1941 and earlier, if in stock 50c per copy.

VOLT-OHM MILLIAMMETER

? *I would like to know how to convert my milliammeter into a volt-ohm-meter. It has a 1,000 ohms-per-volt movement. I require ranges of 5, 50, 250 and 750 volts D.C. and A.C. I have a small half-wave meter rectifier for the A.C. My meter has an ohms scale, which reads up to 1,000 ohms.—A.K., Brooklyn, N. Y.*

A. The schematic is given. You will find the 5-volt A.C. scale will not be correct, and your resistor will have to be varied from the original value of 4,500 ohms to allow for the resistance of the rectifier. This changes with the amount of current through it, making correctness at all points on the scale impossible. Common practice is to adjust it for a correct reading at 2.5 volts. On the higher ranges any error introduced by changing rectifier resistance is too slight to be noticeable. A still higher scale may be added by putting a 45-volt battery, a 40,000-ohm fixed and a 10,000-ohm variable resistor in series with the high-ohms terminal.

Your ohms scale is for low-ohm readings. For the two higher ranges, you will either have to mark a new scale on the meter—in the opposite direction—or use a chart, which can be pasted to the instrument. The medium and high scales should fall together, the one being exactly ten times the other.



INTERFERENCE ELIMINATION

? *I have a Kennedy Model 26 T.R.F. receiver. My problem is interference. I cannot separate many stations received on my set. I do not know how to relieve this condition since,*

a. There are no trimmers across variable condensers.

b. There are no slotted end plates on the variable condenser.

c. All tubes are new as well as many parts.

d. The set is completely shielded.

What can be done to reduce this interference?—B. W., Brooklyn, N. Y.

A. Here are some suggestions which will improve your selectivity and relieve the interference in your receiver.

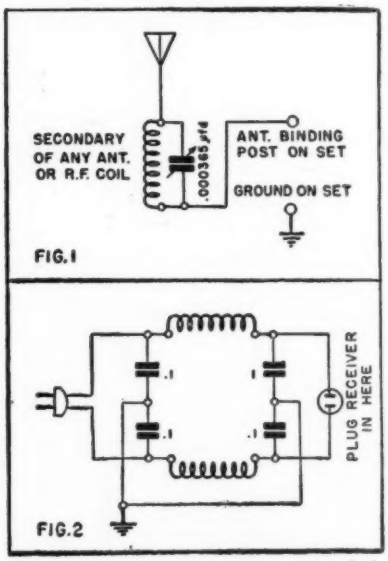
1. Suggest shunting your variable condensers with 30 mmfd. trimmers. Then adjust at the high frequency end of the dial scale when tuned to a weak station in that range of the dial scale.

2. Suggest trying a wave trap which should be adjusted to absorb partly or totally the interfering station. Circuit shown.

3. Suggest shortening your aerial.

4. Suggest changing the direction of your aerial with the "hot end" (point where lead-in is attached to the flat top) away from the broadcast station.

5. A line filter helps once in a while. You may construct one as indicated.



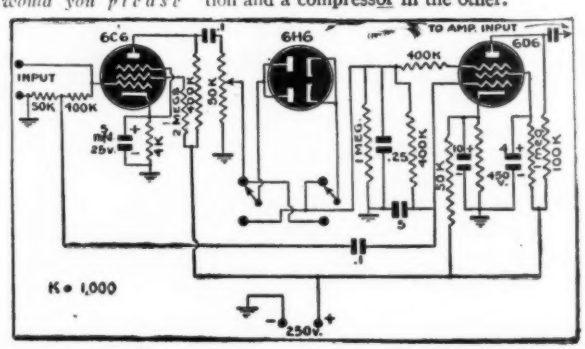
Two methods of interference prevention. Coils in Fig. 2 are half-pound rolls of bell-wire.

VOLUME EXPANDER-COMPRESSOR

? *Please tell me whether or not my volume expander (diagram included) can be used as a volume compressor for making records. I would like to use it between an amplifier with resistance-coupled 6J7 to 6K6 and a carbon mike. If my expander won't work both ways would you please suggest one that will operate with the amplifier. I would especially like to use the 6H6, which I have.—K.H., Portsmouth, Va.*

A. It is not hard to make a volume expander act as a compressor. It increases the grid and suppressor potentials of the amplifier into which it feeds. Reversing the terminals of the 6H6 will cause it to *decrease* the voltages on the screen and suppressor as signals increase.

A double-pole double-throw switch is used to reverse the connections so that your device will work as an expander in one position and a compressor in the other.



We asked 5 foolish women why they don't check ceiling prices

"The storekeeper might get mad"

You're wrong there, lady. Good merchants appreciate customers who keep an eye on ceiling prices, who don't ask them to buy on the black market, who never ask for rationed goods without points, who share and play square with scarce goods.

..."It's too much trouble"

It isn't a lot of trouble to do the little the Government asks—just remember to ask every time you make a purchase, "Is this the ceiling price?" And it's well worth the trouble—if it holds prices down, lessens the danger of inflation.

"We can afford to pay more"

Maybe *you* can, but how about the millions of soldiers' families who must live on Army allotments? Every time you pay black market prices or buy rationed goods without points, you're helping to send prices up—that's the way inflation comes. And *nobody* can afford inflation.

"My store doesn't display ceiling prices"

All retailers will if you keep asking them, "Is this the ceiling price?" It's the law. Ceiling prices must be displayed wherever goods under ceilings are sold. That's the system which has helped to keep prices so much lower in this war than they were in the last.

"I just don't want to do it"

No—and our boys don't want to fight! But they're doing it—magnificently! It's up to you on the home front to do your part to head off rising prices and inflation, help prevent producing a depression for our boys to come home to. Don't be a SABOTEUR on the home front!

Check and be proud! You should be proud if you're the kind of loyal, patriotic American citizen who never pays more than ceiling prices, who pays her ration points in full, who shares and plays square with scarce goods!

It is because of you and millions of women like you—cooperating with American merchants—that the cost of living has gone up only 7 per cent since your Government's price control started.

But the end is not yet. So keep up the good work. Ask *every time*—"Is this the ceiling price?" Never buy a single thing that you can do without. Save your money—in the bank, in life insurance, in War Bonds. When you use things up, wear 'em out, make 'em do, or do without . . . you're helping to HOLD DOWN PRICES!

YOUR STORE WILL BE GLAD TO HAVE YOU ASK:

"Is this the ceiling price?"

A United States War Message prepared by the War Advertising Council; approved by the Office of War Information; and contributed by this magazine in cooperation with the Magazine Publishers of America.

Radio-Electronic Circuits

EASILY-BUILT INTERCOM

I wanted an inter-communication device for two-way communication between my study and the kitchen. I tried several circuits, using different tubes and various types of mikes and speakers.

The final circuit, built up out of what materials were available, is installed in a carrying case and works fine business. The main unit is placed in the kitchen and a speaker is put in the study. The switches are all on the main unit. When I get a call from the kitchen, all I have to do is answer back from where I sit without getting up. The volume is more than ample and the quality of voice is clearly understandable.

The diagram is made out in some detail to avoid the necessity of further explanations. There is a little hum, which could be further eliminated if it were troublesome enough, by the addition of more filter capacity. I tried resistance coupling between the two tubes, but that cut down the volume and didn't help the quality at all. The speakers are old-type magnetics.

ROBERT W. L. MARK,
Wellsboro, Penna.

HI-FI FROM OLD PARTS

The high-fidelity phono amplifier was made entirely from parts obtained from a few old broadcast receivers. It has enough gain to work out well with a microphone, too.

The tubes are common types, and can be substituted readily. Thus, a pair of 56's and a 2A5 would give results not much different from those with the tubes given. If you have a later set with 6-volt tubes, you can use a pair of 6C6's and any one of the 6-volt output tubes, such as the 41, 42, 6F6 or 6K6. The rectifier should, however, be one that can deliver at least 125 Ma., for best results.

If your power transformer has no center-tap on the 2.5-volt filament winding, a tapped resistor connected across the 47 filament will work. Use a 20- or 30-ohm center-tapped resistor and connect the 600-ohm cathode-biasing resistor to the center-tap.

GEORGE S. BAHRS,
Burlingame, Calif.

EXPERIMENTERS

Radio-Craft **is initiating a plan to overcome the bottlenecks created by the unavailability of many standard types of apparatus. The ingenuity of the American experimenter, technician and mechanic is hereby challenged to replace, rebuild or substitute unrepairable or unobtainable equipment.**

Every month one project will be announced for the readers of this page to exercise their brains on. ***Radio-Craft*** **will pay a**

FIRST PRIZE OF $5.00

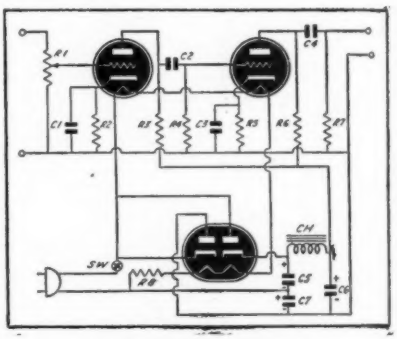
for the best answer and one-year subscriptions for all others published.

PROJECT FOR THE MONTH: Bottleneck No. 2—A simple and easily-constructed all-wave signal generator, accurate enough for fine service work, is needed on many a radioman's bench today. What can YOU do to solve this problem? Let's have circuits, photos and stories.

Suggestions from readers as to other bottlenecks are also welcome. What is your present pressing problem? If you want help with it, tell us so that we can all get to work on it.

A HIGH-GAIN PRE-AMPLIFIER

This is a fine hi-gain (theoretical voltage gain 4900) hi-fidelity voltage amplifier. Its uses are legion. It makes a fine pre-amplifier for PA work or it can be attached to a receiver to build up its output for headphone reception. It can also be used with a relay for photo-electric cell work or for almost anything else you can think of.



The frequency response characteristics are excellent. Response is almost flat from its low frequency cut-off (around 100 cycles) to high frequency cut-off which is well above the audio range. Low frequency cut-off can be raised or lowered by multiplying the values of C2 and C4 by 100 and dividing by the desired cutoff frequency.

For use with a radio receiver to secure increased audio gain the values of C2 and C4 should be changed to .0025 or .002 which gives a low frequency cut-off near 200 cycles. The reason is that due to static crashes, etc., the amplifier may become overloaded and motorboat. Raising the cut-off frequency considerably reduces the chance of motorboating although it does not hurt the fidelity of the amplifier too much.

When receiving voice this loss of fidelity is not objectionable or even noticeable unless one is quite critical. In fact this in many cases is a blessing in disguise since it considerably reduces static which usually is of a fairly low frequency and which is also cut off.

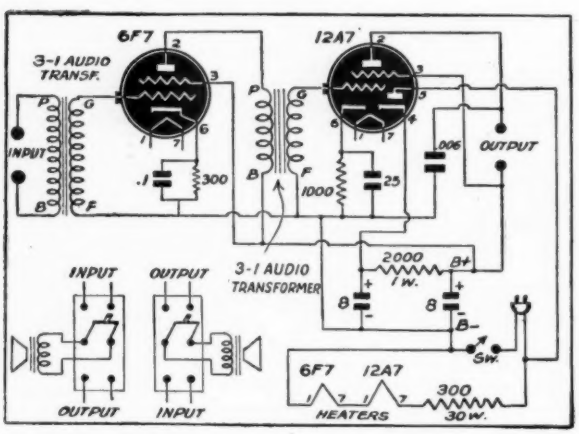
This rig can be built quite cheaply since there are no expensive transformers to buy, and the single choke can be any you have around or even the primary of an old output transformer.

Parts List

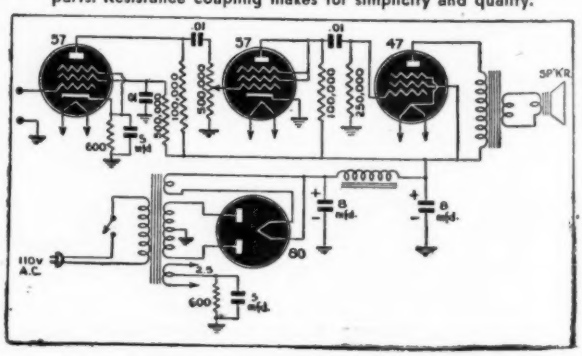
R1—.5 Meg Pot	C2—.005 Mfd.
R2—1500 Ohms	C3—5 Mfd. 25 V
R3—.5 Meg	C4—.004 Mfd.
R4—1 Meg	C5—16 Mfd. 450 V
R5—1500 Ohms	C6—8 Mfd. 450 V
R6—.5 Meg	C7—16 Mfd. 450 V
R7—1 Meg	V1—6F5 or 6SF5
R8—260 Ohms (line cord)	V2—6F5 or 6SF5
C1—5 Mfd. 25 V	V3—25Z5 or 25Z6
	CH—A.C.-D.C. choke

All resistors ½-Watt unless otherwise specified.
All condensers 400 Volt unless otherwise specified.

WILLIAM M. LUEBBERT,
Los Angeles, Cal.



Left: The simple intercommunicator described by Mr. Mark. Only the pentode of the 6F7 is used. A 6J7 could be substituted here. Below: A phonograph amplifier easily constructed from old receiver parts. Resistance coupling makes for simplicity and quality.



A MESSAGE TO MANUFACTURERS

47,000 men from LONDON to SYDNEY . . .

. . . read RADIO-CRAFT this month!

47,000 men engaged in every form of vital communications the world over read RADIO-CRAFT this month . . . . 47,000 men of the military and industry! . . . . applying their pre-war skills to the essential needs of their country.

The demands of war have denied these men many of their peacetime habits . . . . but, you can bet your boots, reading RADIO-CRAFT is one habit they continue to keep, because it keeps them abreast of the important developments in Radio Electronics that will influence their post-war achievements. The place of your company's products in their deeds of tomorrow can be influenced through the advertisements you place before them in their favorite technical magazine today.

A comprehensive Survey of the radio and electronic field has just been completed. Among other interesting facts revealed, it shows which magazines technicians are reading during these critical times. Send for this survey today! Free to manufacturers and wholesalers writing on their own letterheads.

— at less than — 1¢ PER READER you can reach 47,000 Radio-Electronics men with

RADIO CRAFT AND POPULAR ELECTRONICS

25 WEST BROADWAY, NEW YORK 7, N. Y.
Member of the Audit Bureau of Circulations

TRY THIS ONE!

SENSITIVE VOLTAGE DETECTOR

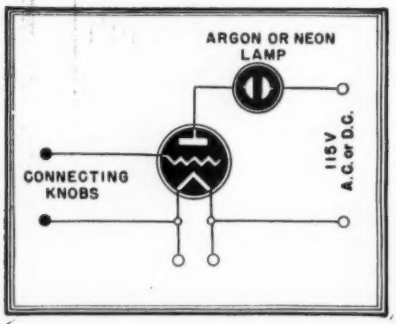
A schematic for this vacuum-tube electroscope is shown here. This device is exceedingly sensitive and it may be used for detecting static and galvanic charges.

In determining the polarity of a static charge the electrified object is brought near the grid lead. If the charge is positive, the argon lamp brightens, if negative, it darkens. The polarity of a cell or battery may thus be found by connecting it in series with the connecting knobs and noting brightness of the lamp.

Many of the gold-leaf experiments work well with this device. Shielding the tube helps to improve its performance.

AVIS SAVATGY,
Kingston, N. Y.

This "floating-grid" voltage detector has been described in *Radio-Craft* before, (Floating-Grid Relay, June, 1943) and, properly made, is a very sensitive device. —*Editor*



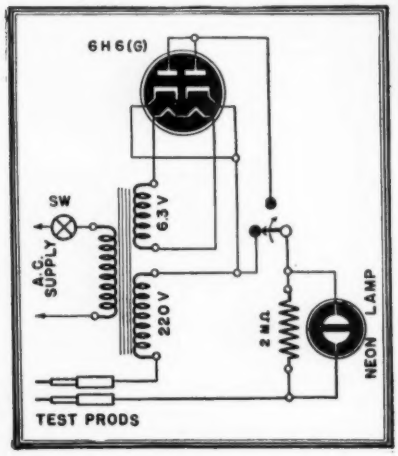
A.C.-D.C. CONDENSER TESTER

The instrument as shown in the diagram will test condensers on either A.C. or D.C.

Electrolytics are tested on D.C. by proper switching. By using A.C. (on other types) it is possible to estimate condenser capacitance by noting the brightness of the neon glow. The greater the capacitance, the greater the glow.

Open condensers show no light. Intermittent ones give an intermittent glow.

E. MENZEL,
Tel-Aviv, Palestine



REMOVING WAX FROM COILS

Many oscillator, I.F. or similar wax-coated coils are easily repaired by the competent technician if the wax coating is first removed in the following simple and effective manner.

Fold three or four layers of ordinary Kleenex or similar absorbent tissue over the coil and press lightly over this with a hot soldering iron. The heat will melt the wax and the tissue will absorb it.

The coil is left practically wax-free for an easy repair job.

MERRITT OBERHOLTZER,
Mifflintown, Penna.

EASILY MADE SOLDER DISPENSER

This pencil-type solder dispenser devised at General Electric's Schenectady Works prevents contamination of solder from handling and dirt. It was made of a piece of methyl methacrylate resin tubing. The brass nozzle is cemented into the body of the tubing with a press fit. Before loading the solder into the dispenser, it is form wound on a drill rod in a bench lathe. The operator pulls the solder from the dispenser with pliers as it is needed.

"PARTY LINE" TESTER

After constructing the "Party Line" unit described by Mr. Lindsay Russell (July issue) I find that it is a "must" for the serviceman's bench, when working with audio stages using transformers.

I use a small speaker field as a pick-up and find it excellent for checking audio amplifiers and receivers. When it is brought close to an audio transformer or output transformer, the signal is audible through the "Party Line" unit, thus making a signal tracer for A.F.

ATKINSON RADIO SERVICE,
Zanesville, Ohio

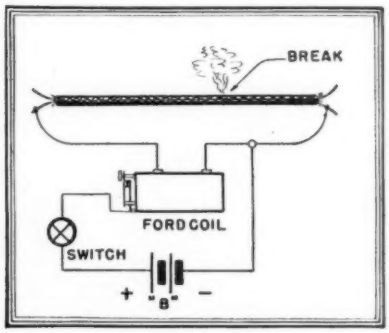
BROKEN WIRE INDICATOR

This is a useful and simple test instrument to have around the home or shop.

Many radios or other electrical appliances are out of order because of broken wires in cloth or rubber covered cables. These breaks may be found by connecting the hot leads from a model T Ford coil to each end of the wire to be tested.

If the wire is broken the break will be indicated by smoke or even a very small flame.

CHARLES MANN,
Rouzerville, Penna.



CLEANING OF DIALS

The old-fashioned black bakelite dials which are about the only type available now may be polished and cleaned up to make an excellent appearance.

First clean them well with good old soap and water, and dry. Next, you will probably notice that the numerals around the edge are dirty and yellow. Take a white crayon and go over all numbers and lines, filling them in. Wipe off the excess with a cloth. The ordinary wax of a white crayon will give as good effects as any other whiting material I have ever tried to use, and does not crack or fall out.

Last of all, to give it a really shiny coat, polish the dial with ordinary furniture wax, after which any radio man would be proud to put it on his panel.

JAMES LONG,
Rennselaer, Ind.

HANDY WIRING AID

A thin piece of Plexiglass 8" x 12" is sandpapered on one side only, or it may be sand-blasted, to give it a rough surface on one side. Now place over the diagram from which you are working, fastening the Plexiglass down with thumb tacks.

The diagram can now be easily read and all you have to do is trace over the part of the circuit already wired, thus showing you what is yet to be done.

The Plexiglass is not easily scratched or damaged, though of course ordinary care must be taken not to mar it, and probably scratches could be sanded or ground out.

The glass may be washed or erased very easily and used over and over. The original diagram will not be soiled or marked up.

R. M. STELLMAKER,
Miami, Fla.

PHANTOM SOUNDS

(Continued from page 652)

safely be assumed that they have a negligible effect in extending the frequency spectrum upward.

Recent research in the physiology of hearing has led to general acceptance of a theory of subjective tones based upon the response of the tympanic membrane (eardrum) to auditory stimuli. It is probable that the vibration of the membrane is symmetrical only for sounds of a low order of intensity owing to the damping effect of the *ossicles* (small bones in the middle ear) in transmitting the vibration to the inner ear. Thus the ear mechanism exhibits a non-linear response to sounds above a few decibels in loudness, the degree of non-linearity or distortion being proportional to the intensity. It has been demonstrated mathematically and corroborated by experience that the distortion of sound results in the presentation of a somewhat different complex of overtones than that present in the original stimulus. A sine wave greatly amplified would be heard as a fundamental plus a series of overtones, a distortion introduced by the ear mechanism. It seems fairly conclusive that certain difference tones as well can be explained on the basis of the non-linear response of the ear, an assumption borne out by the fact that the apparent loudness of these tones is in direct ratio to the intensity of the generating sounds.

An additional factor that must be taken into consideration is the marked insensitivity of the ear to sounds of low frequency, and a similar falling off in sensitivity to frequencies above 5,000 cycles. Curves adopted by the American Standards Association show that the energy in a 30-cycle tone required to make the tone just audible is more than a million times that required by a 1000-cycle reference tone at the threshold of hearing. Stated in another way, the 1000-cycle reference tone has an intensity of 0 decibels at the threshold, while the 30-cycle tone must have an intensity of over 60 decibels in order to be heard.

With the foregoing factor in mind it is possible to examine with some degree of objectivity the proposal referred to at the beginning of this article. As mentioned above, we may discount the importance of summation tones as a negligible factor in extending high frequency perception. The question, then, is whether or not the proposal to strengthen the impression of low frequency subjective tones by artificial means applied at the broadcast transmitter is fundamentally sound, assuming that the broadcast receiver is not changed as to its frequency response.

Since the perception of such tones depends upon the presence of upper partials in a harmonic relationship ($2 \times$ fundamental frequency, 3f, 4f, ... etc.) so that the fundamental will be reinforced (or *supplied* in the case of a receiver lacking in bass response) by difference tones, and since the apparent loudness of these tones varies in relation to the intensity of the generating sound, it is obvious that any apparent reinforcement must be accomplished by increasing the intensity of upper partials. We may rule out the strengthening of the entire spectrum as accomplishing nothing that cannot be achieved by turning up the volume of the receiver. It will be shown that the only remaining possibility, that of strengthening a selected band of frequencies, presents such serious consequences as to make application totally inadmissible.

A study of the frequency spectra of various orchestral instruments shows that each one possesses its own characteristic pattern of overtones, differing from others in both the number of overtones present and relative degrees of intensity. It is this characteristic pattern of overtones that lends to each instrument its individual tone quality (disregarding the formant theory of timbre). It is immediately apparent, then, that the artificial reinforcement of any block of frequencies would result in serious harmonic distortion to the extent that the characteristic timbre of instruments would be radically altered in reproduction, and the tone quality of the same instrument would differ according to register as the relation changed between the fundamental tone and the artificially reinforced overtones.

The reproduction of low register percussion instruments of indefinite pitch, such as the deep gong and the bass drum, presents a serious problem in equipment with *(Cont. on following page)*

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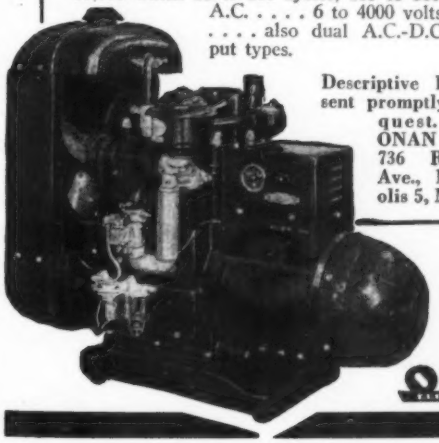

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(Continued from previous page)

an attenuated low frequency response. Since these instruments are of indefinite pitch, the tone produced does not present a series of overtones in a simple harmonic ratio; for this reason a subjective impression of the characteristic low-frequency component is impossible in the absence of fixed pitches that might provide a difference tone. Reproduced through inadequate equipment, sufficient middle and high frequency sounds associated with the tone production of such instruments come through to make recognition possible, but the fundamental low-frequency characteristic is entirely lost. In this case no amount of harmonic reinforcement will strengthen a subjective impression that is absent to begin with.

Finally, the original premise on which the proposal under discussion is based, namely, that subjective tones can furnish a satisfactory substitute for objective ones, is open to serious question. At this point the trade statistics must be reckoned with, for, considering the number of midget radio receivers that are in the hands of listeners, quite a proportion of the listening public is apparently satisfied with a radically abbreviated frequency spectrum. While the situation is harmless enough in speech reproduction, one wonders whether this group knows what it is missing when it comes to music. It is not the purpose of this article to launch a discussion of public indifference to wide-range fidelity, but it would seem possible that a simple side-by-side test of music reproduced on a sawed-off spectrum, and then through equipment of even moderate fidelity, might convince some radio listeners that there is sometimes "more than meets the ear." A test of this kind offers, in most cases, the only means of making apparent the tendency of the human ear to adjust itself to and accept any kind of sound reproduction, no matter how inadequate.

It has been indicated that summation tones contribute little or nothing in the way of providing an illusion of high-frequency tones that are weak or absent in reproduction. Yet an adequate response in this region of the spectrum is just as essential to naturalness of music as good low-frequency output. Without it, instruments of the woodwind group in particular tend to lose their characteristic timbre in the upper registers as the strength of the overtones falls off. Certain percussion instruments also, such as the suspended cymbal and glockenspiel, suffer greatly from an attenuated high-frequency response because of the large concentration of energy in the high register. The most immediately apparent result of insufficient highs in reproduction is, of course, an overall lack of crispness, plus the destruction of "auditory perspective," or "extensity," both terms referring to the illusion of music occupying "auditory space." This latter is an important attribute of listening not usually taken into consideration.

The current interest in frequency modulation transmission has served to emphasize the inadequacy of amplitude modulated broadcasting, both in frequency range and in dynamic range from soft to loud. It is the author's hope that the wide development of FM network transmission, divorced from the limitations of wire lines, will prove economically feasible in the immediate post-war period, since at the present writing, it is the one system ready for immediate application that offers a wide-range audio channel to the radio listener.

(Author's note: The item in *Radio-Craft* referred to at the beginning of the foregoing discussion gave the figure 5000 cycles as the upper limit of hearing. This was an error, the limit being much higher, some figure around 15,000 cycles usually being given. The author has made informal tests with an accurately calibrated beat-frequency oscillator, and has found that the upper limit fell in most cases between 12 Kc. and 17 Kc.)

●

Plans have been completed for the erection of a government television transmitting station atop Mount Royal in Montreal. Work on the transmitter will begin as soon as materials become available. G. W. Olive, chief engineer of the Canadian Broadcasting Company, predicted that most of Canada should have video facilities within the next decade. Research into suitable programming has already been started and no time will be lost in launching the station once equipment is available, it was stated.

Suggested by Marguerite Muchmore, Encinitas, Calif.

"I'm trying to locate the bobby-pin you fixed this radio with six weeks ago."

RADIO MONTH IN REVIEW

(Continued from page 651)

hour during the day, the highest number occurring near sunrise and the fewest near sunset.

It was pointed out these bursts may be related in some way to bursts of somewhat longer duration and greater frequency of occurrence which have been reported by other engineers on frequencies below 20 megacycles. The distances over which the FM bursts are received, as well as certain measurements of signal path length, indicate they are ionospheric in origin, just as are the bursts at the lower frequencies. There is also substantial agreement between the daily variations in the FM bursts and the lower frequency bursts which is further evidence that they are related and may perhaps be due to a common cause.

Bursts were also observed by commission engineers on certain television stations at 72 megacycles, but insufficient data have been collected on these to make any determination of the relative amplitudes, frequencies of occurrence and durations as compared with the bursts in the FM band.

In accordance with a commitment made when the F.C.C. met November 17, 1943, with representatives of the Radio Technical Planning Board, the Interdepartment Radio Advisory Committee, and the Board of War Communications to discuss organization and procedure to be followed in post-war planning, the Commission has made a preliminary report on bursts in the FM band to the R.T.P.B.

Commission engineers are continuing their observations and it is hoped data will be obtained which may serve as a basis for approximating the amplitudes and numbers of the bursts to be expected at various distances from a transmitter at any given time. This determination involves not only a long-time measurement of burst amplitudes from FM stations, but measurements as well of the path lengths and directions of arrival of the signals, in order to identify the medium causing the bursts.

In addition to the burst signal interference described above, there is another distinctly different kind of interference to very high frequency reception which has been recognized for some years. It happens occasionally that a normally unheard station will come in with sufficient signal strength to operate a receiver satisfactorily for a considerable length of time—many minutes or even hours. This effect, easily distinguishable from the burst phenomenon by its duration, can be produced by transmitters of low power and has been known to produce a signal sufficiently strong to take control of a receiver tuned to a local station on the same frequency. The cause of this phenomenon has been traced to abnormal "patchy" ionic densities in the lowest of the ionospheric layers—the "E" layer, and is known as "sporadic E transmission." While much data on this effect has been accumulated at lower frequencies, more are needed for the very high frequency region of the spectrum and it is hoped that the present recording program of the commission will help to supply the need.

Both of these interference effects are being studied by the appropriate panels of the Radio Technical Planning Board and with this cooperation and that of other interested organizations, it is believed the commission will find a satisfactory solution of the problems involved, should further investigation show that they are actually important in FM reception.

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WINDOW DISPLAYS FOR RADIOMEN

Radio servicemen are, as a rule, tempted to dispense with windowizing for the duration. "After all," the typical radio man reasons, "windows are primarily used to attract more patronage, and of all things that I need, increased traffic is definitely not Item No. 1."

Not so certain progressive servicemen of Northern New York. Mattraw of Watertown, Bartlett of Syracuse, Rochester Radio and Television of Rochester, Alberts of Syracuse and other radiomen believe in wartime windows specifically planned to get across to the customer the fact that when a king-sized war is going on radio service is bound to be affected somewhat. Let's see what makes some of these prize-winning displays tick.

One of these enterprising radiomen designed a pair of paper clocks with 24-hour time indication. In other words, numbers one through twenty-four were placed on the dial in brightly colored crayon. A poster in front of the clock carried the 24-hour schedule which read, "If we only had 24 hours a day to work we could make home calls."

The other paper clock was of typical design but carried only numerals one through ten, again in easily-observed crayon. A second poster, conveniently staged near the second clock, read, "But we have only 10 hours a day to work—Help us make the most of our time by making your own pickups and deliveries."

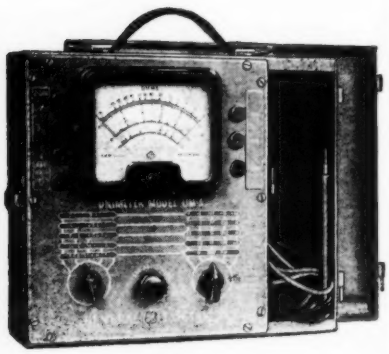
Another effective windowizing was a slight variation of the paper clock display. The hands of the first clock are set at 9 A.M. and the second clock reads 5.30 P.M. A poster set in between the two timepieces reads, "We are open between."

Banners were featured for every day of the week from Monday through Saturday. The banners were simple scraps of paper, of the white wrapping variety, with lettering featuring the serviceman's own idea of design. On each banner were the hours a shop was open on that particular weekday. Many shops now close on alternate days, or for a part of every day. This window keeps the customer up to date on the shop schedule.

It will be noted that these window displays consist largely of cardboard posters which can be prepared by high school art students. Most of them hammer home some important phase of wartime radio servicing. They take little time to prepare and will pay handsome dividends to the serviceman taking time out to prepare them for his or her radio establishment.

The purpose behind these wartime window displays is, in every instance, to assure the cooperation of the public. Many times newspaper or radio advertising is not as effective as it might be because of the wealth of other material contained in the pages or programs, but the serviceman's window will be watched every week if it is made interesting to those passing by. Dozens of windows could be designed, employing minor variations from the above themes, easily dreamed up by the radio serviceman, and the dividend will be forthcoming in the not too distant future. This dividend is the increased cooperation of the public with the service shop during the wartime radio servicing period.—*E. A. C.*

UNIMETER



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SALLY, THE SERVICE MAID

(Continued from page 657)

Corporal, Sir. Oh! Please cancel the Sir; I remember . . . now."

"It's okay; fair enough," he said. Then: "How's everything these days? Any more Emersons?"

"Oh, can't complain—much," said Sally. She tried to avoid staring at him, but it was so nice to see him again. So very nice. He looked different. She didn't know just what it was, but she was sure she noticed a great change in him.

"I'm well, couldn't get down last month," he said. He was embarrassed, ill at ease.

Then she noticed his tanned left hand rubbing his right shoulder. "Hurt? You weren't hurt, were you, Danny?"

He looked up and noticed her smooth face was suffused. Grinning, he said: "Not too much; one of the boys didn't know his own strength."

"You—you mean," said Sally, reproof in her voice, "that you had a fight?"

The Technical Corporal shook his head. "No; we were practicing Commando tactics. It's wonderful stuff. But, once in a while somebody forgets how dangerous this can be. Twisted shoulder—not a bit bad. I'm okay . . . now. Well, what have we on the menu for this morning? Let's see your toughest radio repair job."

She was dying to ask him more questions, but she realized there were some things he could not tell her. And she was not going to be nosey, particularly about military secrets!

"Ever prowl around in an old Edison?" said Sally. "It's a model R5, or R4, or C4. Guess they're all about the same. I can handle everything, except for that dual volume control with the two separate switches." She handed him the schematic.

Carefully studying the schematic, he said: "Worked on one of these—long time ago. Trouble was condensers, not the volume control. But . . . H'm'm'm, lemme see . . . uh-huh . . yes . . . I see . . . okay!" His forefinger traced out the leads in the schematic. Then he asked for a pencil and a few sheets of paper.

"This sketch," he said, "the one we'll call Figure 1, shows only the cathodes of the first four 27's. The first three, marked V1, V2, and V3, are the radio frequency stages. The fourth one is, of course, the detector tube. All that concerns us, at the moment, are the cathode circuits of V2 and V3. Only those two tubes are affected by the volume control. That's why I made their leads heavier than the rest. And don't worry because I've shown an ordinary antenna coil, instead of the special coil actually used here. We're not interested in the inductances, at the moment."

Sally studied his sketch, then said: "I see—only V2 and V3 are in the volume control circuit. But I can't quite visualize what happens when the volume control is rotated."

Quickly sketching another diagram he said: "In this sketch, Figure 2, I have shown two separate volume controls. In Figures 1 and 2, each section is marked 'A' and 'B'. Now do you see?"

"Oh, yes! Section 'A' affects the bias of the two tubes, V2 and V3; and section 'B' acts as a variable shunt across the primary of the antenna coil. Now I get it!"

"Now," he said, "let's see you make a *single* volume control do the work that a *dual* control used to do." He handed her the pencil and their hands touched for a moment. He quivered slightly.

Sally's hand shook for a few moments and the lines she drew were wavy. Then, gritting her teeth, she made a new diagram. "Figure 3," she said, without looking at him, "a *single* volume control doing the job of a *dual* control. As cathode resistance is decreased for greater sensitivity, the variable shunt across the antenna primary increases in resistance. Right?"

He nodded. "One hundred percent."

Clearing his throat, he continued: "Our standard, single control will have a single-pole single-throw switch, for the A.C. line. But we may find it impossible to find a switch which includes that extra single-pole double-throw switch, for the phonograph."

"But Mrs. Cartwright—the owner—well, she insists on using her phonograph. She loves good music. Very wealthy; she has several later radio combinations, but she prefers the Edison. She insists it has better tone quality."

"She shall have her phonograph," he replied. "But we'll have to add a toggle switch, single-pole double-throw. Or use a rotary switch with a pointer knob; mark it PHONO-RADIO. You may be able to buy one of those plates. Maybe you have one in stock." He picked up the pencil she had left lying on the counter and made another

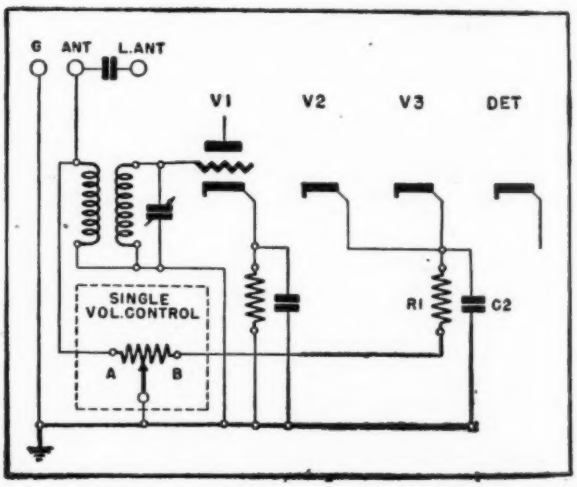

Fig. 3—The new single volume control replaces the old dual unit. As the control is turned, bias on the controlled cathodes is increased. At the same time the antenna is shunted with a progressively lower resistance path.

sketch. "Figure 4," he said, "shows how to connect the phonograph switch."

"Thanks, Technical Corporal!" said Sally. "I wonder what I would ever do without your help."

He nodded, grinned, then said: "Another thing—as this customer enjoys good music, why not rewire the phonograph circuit? Use a crystal pickup, for better tone quality. You could, of course, rewire the whole audio amplifier, but that may not be necessary. This particular model, old as it is, has pretty good tone. Besides, as she's used to it she might not like improved quality."

"Thanks a million," said Sally. "I hope you realize how very grateful I am for your help. I wish I could pay you. After all, *I* get paid, why shouldn't *you?* Oh, please—!"

"See you next month," said the Technical Corporal. Then he was gone!

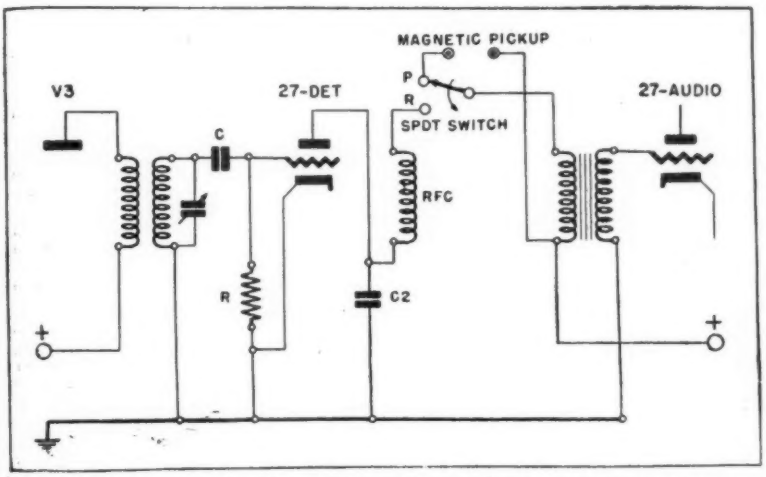

Fig. 4—The job was completed by installing a phono switch as shown in the circuit above.

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 (Continued from page 662)

is carried to a powerful amplification system and loud-speakers.

The method shown in Fig. 5 has been mentioned in our previous reference to the photoelectric cell. This system has also been used in experimental organs and other electronic musical instruments.

The reproducing system shown in Fig. 6 employs photocells and sound photographed on the edge of movie film. This may be done either by the variable density or the variable area method.

RECORDED SOUND

Of vast importance to the young student of electronics is the recording of sound on wax discs. The sound is not only recorded electronically but is also reproduced electronically. The music or voice reaching the recording microphone is first amplified and then carried to an electrodynamic stylus or cutting head pressing down on a revolving disc.

Reproduction employs a pick-up which is really very much like the cutting head. Here a needle contacts the sound grooves and carries the vibrations to a reed armature magnet set inside a field coil. The device is really a dynamo save that the armature vibrates in place of revolving. The small current generated in the field coil is carried to powerful electron tube amplifiers. A disassembled magnetic phono pick-up is illustrated in Fig. 8. The several different methods used in connecting pick-up units to amplifiers are illustrated in Fig. 9. Proper impedance relationships must be established, along with a minimum of scratch noises.

THE UNIT OF SOUND

Some years ago, the able physicists of the Bell Telephone Laboratories found themselves in need of a scientifically justified unit for the measurement of sound. The electrical engineer had his volts and amperes, the mechanical engineers had foot pounds and horsepower, but there were nothing but leaky buckets into which bundles of sound energy could be poured. A unit called the bel, in honor of Alexander Graham Bell, was developed. Appropriately enough, the bel was used to calculate the rate at which telephone signals faded when they were called upon to survive the electrical intricacies of modern circuits. One bel represented a sound strength ten times above an arbitrary zero level, two bels an intensity 100 times zero level, three bels 1000 times, etc., on up the scale. Zero marked, not the end, but a definite limit like the zero mark on the centigrade and Fahrenheit temperature scales. The bel was more or less cumbersome when used to measure very small differences in sound level that could not help but prevail in a continuous spectrum. The decibel, which divided bels into tenths, was therefore introduced. This is the standard yardstick used in sound today. On an energy basis, a decibel represents a fraction of a millionth of a watt. It is only when we measure ordinary sounds that we are able to fasten some meaning to the unit. Today, we have sound meters that give decibel readings. A rustling leaf generates 20 decibels of sound, a lion roars at 95 decibels, a riveting hammer has a 105 decibel clatter. Beyond 130 decibels, we reach an area where nerve response degenerates into severe pathological disturbances and sound may stimulate pain, even succeed in bringing about disruption of organs.

Sound, long regarded merely as some kind of a vague atmospheric disturbance through which we hear, has finally entered the world of everyday affairs. It has assumed sociological and economic importance. The nerve-bedeviled fellow twitching in his subway seat is partly a product of the sound that assails him. His anxiety neurosis is not caused entirely by the market, his job or his boss-ridden office. Sound, too, leaves its mark, makes him a more inefficient producer. He suffers shell shock each day of his existence and his employers, his city officials, are becoming anxious if not worried over the matter. Many of our large cities are now having sound surveys made in which the meter calibrated in decibels is used to trace down and condemn the chief offenders. Manufacturers of electrical appliances and moving machinery, quick to sense factors in the popularity of their products, are also busying themselves in an effort to cut the noise produced by their products to a minimum and thereby contribute to the well-being of those who use their equipment.

We ride in airplanes, automobiles and railway coaches that have been OK'd with decibel meters; we are beginning to use electric fans, vacuum cleaners and washing machines that have been reared within the measuring ears of decibel meters. The Noise Abatement League would have every manufacturer mark his machine with the decibels of noise it produces. Should sound enter the competitive field, the public would rapidly become sound-conscious and demand a minimum of unwanted noise with each thing it bought. London has already demanded that motorists refrain from blowing horns at night and Mussolini decreed "silent days" and threatened to remove the confines of Rome factories that violate the limits of ordinary endurance. Factory owners in this country also have found that they owe it to their employees and their output to minimize noise. A man working a noisy adding machine will make more mistakes than a man operating a quieter one. Mechanical engineers, for the first time, have been called upon to develop machines that will not shatter the nerves of those who attend them.

●

Radio's contribution to the war effort in 1943 exceeded $202,150,000 in station and network time, the National Association of Broadcasters reported on the basis of monthly reports from station members and OWI allocations.

Calculated on one-time rates before discounts and commissions were deducted, the radio time provided by individual stations totaled $96,506,000, while networks supplied $105,644,500 worth under the spot and special assignment plans.

●

Mr. L. A. Cleaveland, foreman in the radio and test department at American Export Airlines, uses a barber chair with the back, seat and arms removed as a test stand for automatic direction finders.

A platform was built where the seat would be and a superstructure added to house the automatic direction finder. The base of the chair was used as the compass and the 360 degrees marked off on it. A pointer was affixed to the platform and bent to point to the degrees of the compass.

The equipment was placed in a shielded room and an aerial run from 0 to 180 degrees made. The equipment thus checks the instruments perfectly.—*J.R.Y.*

STAGE-BY-STAGE TESTS

(Continued from page 669)

signal will come through. Then, shifting the connection of the generator to the grid of the 6K7, a much louder signal should be heard, indicating the 6K7 is contributing to the gain of the receiver. The receiver's volume control should be at maximum when making these tests. Next the generator is connected to the grid of the 6A8, with the receiver dial set at 550 Kc. and the generator dial set at the I.F. The receiver circuit is disturbed by the addition of the test cable and the shunt impedance of the generator, but practical servicemen find such objections in consequential and use the tests every day in their work.

Suppose the I.F. signal gets through from the 6A8 grid to the loud-speaker and yet the radio does not pick stations as the dial is tuned over the band. This defect points most probably to oscillator failure. There is a simple way of checking the oscillator. Set the service generator for unmodulated output, couple it loosely to the grid of the mixer by attaching the generator cable clip to the insulated grid wire (no direct connection). Then advance the generator output control or attenuator to about half-scale. The receiver dial may be set at about 1000 Kc., volume advanced to maximum. The generator dial is then tuned from about 1000 to 2000 and if a number of stations are heard it is clear the receiver's oscillator circuit is not working. Beat notes will be heard if the receiver's oscillator is working. Another way of checking the receiver oscillator is to connect a high resistance voltmeter between the oscillator grid and cathode, the negative terminal of the meter going to the grid, the positive to the cathode. If a reading is obtained with the instrument set on the 0-10 volt range, the oscillator is working. If a reading is not obtained, or a reverse reading is given, the oscillator is not working and should be checked. There may be an open oscillator coil, shorted oscillator tuning condenser, or a lack of anode and filament voltage on the oscillator causing the trouble.

A RADIAL-BEAM TUBE

(Continued from page 653)

system proved impractical because of mechanical difficulties. The present tube will, of course, eliminate these difficulties. Incidentally, this type of communication does not require the elaborate filters of the carrier system, now in wide use.

Two tubes of the radial beam type have been operated successfully in New York for experimental signalling. A neon tube in the anode circuit of each element was used as indicator. The only amplification provided was that of the tube itself! Both transmitting and receiving tubes were connected to the same source of 60 cycle A.C. so that automatic synchronism of corresponding anodes was obtained. Much will probably be heard of this tube in the near future.

●

The human eye as a light-sensitive device far exceeds any other known system of light detection. The smallest amount of light capable of stimulating the eye has been found to be between five and 14 quanta. This is two to six trillionths of the energy required for a flea to jump about four inches high.

TELEVISION IN THE SHOP

Industrial television was launched with the U.S.S. *Missouri*, when several hundred of the General Electric workers who produced its powerful geared-turbine propulsion sets and a large variety of operating and ordnance equipment used by it, saw its christening ceremonies in their own shop.

Three television receivers were installed in the turbine shop, enabling the workers to watch the launching, 150 miles away.

The telecast, first ever made of an event so closely connected with the war, was sponsored jointly by the General Electric and National Broadcasting Companies, both of whose television stations—WRGB, Schenectady, N. Y., and WNBT, New York City—carried the show. This two-station chain, which has been in operation for some time, is the first television network.

PROGRESS IN INVENTION

(Continued from page 674)

different elements so that it is necessary to avoid sharp corners and surfaces must be highly polished. In the type of electron lens shown, however, the metallic electrode—seen at 6—is imbedded in a solid possessing high insulating strength. Then by proper shaping of this material as well as the electrodes themselves, it is possible to minimize aberrational effects with less danger of breakdown.

A typical shaping of the lens is shown. Materials which may be used are glass for the solid dielectric and platinum for the electrode, which may be in the form of an annular disk or washer having at its inner edge a ring of circular cross-section.

Since the development of electron microscopes depends greatly on improving the electron lens, such inventions may be of great importance.

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is thoroughly covered in this book in easy-to-grasp language. Among the articles on this subject are: **What You Should Know About Electronics—Electronic Tubes for Servicemen—The Electronic Solovox**, its theory and action—and **The Photo-electric Phonograph Pickup**, the principles underlying its operation.

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Among the interesting and easily constructed devices selected are the following: **Compact Hearing Aid—Oscillaplex Automatic Key and Code Machine—Electronic Relays, Capacity and Light Operated, High Frequency Radiotherapy**, a complete home apparatus—and many other timely types of electronic apparatus.

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induced in it by L_1 is thereby reduced to a very low value—roughly that of the actual resistance of the wire in the coil, and therefore high voltages are generated in it.

Now that the oscillator has produced alternating current, we can see its real use. Consider the "tank-circuit" L_1 C_1. The coil and condenser are in parallel. The design of these elements is such that at the fundamental oscillating frequency they offer maximum impedance. The A.C. component of voltage in the tank circuit is:

$E = IZ$ where I = circulating A.C. current
Z = impedance of tank circuit

Thus, no matter how low the A.C. current is, with a maximum tank impedance the A.C. voltage (reactive voltage) is likely to be high. In the circuit described this value can go up to 200 volts or more.

The tank coil acts as primary for the transformer L_1 L_2, the secondary of which is connected to the rectifier. From there on the circuit is exactly like a half-wave rectifier operating from a power transformer off a 60-cycle A.C. line. That's all there is to it!

As we draw current from the rectifier circuit (the diode end of our 25A7), which is attached across this coil and condenser combination, the voltage drops. An oscillator built up according to the specifications of this article is therefore unsuitable for such work as operating large power tubes, where heavy currents are needed. It is, however, useful for many small devices.

One of the greatest practical uses of this type of power supply is for applications where very high voltages with low currents are required. A single 6L6 oscillator has been used to supply 6,000 volts to be rectified for a cathode-ray tube, and the G-E "suitcase" electron microscope uses a resonant-type power pack.

CLASS OF OPERATION

To get appreciable power output from a power-oscillator stage, some form of plate-grid feedback must be employed. It must be remembered that frequency stability varies inversely with closeness of feed-back coupling. Thus with close coupling for maximum power transfer, frequency stability will suffer. This is of no consequence in the circuit where the output is immediately rectified to produce D.C. power. Under these conditions the circuit may be referred to as Class "C" power-oscillator.

Some thought should be given to the energy required for the grid circuit. The grid draws both voltage and current. This power cannot come from the preceding stage as it usually does with Class C stages . . . . There is no previous stage! The grid power must come from the plate-circuit power supply. The characteristics curve of such a stage would then show E_g–I_p relations far out in the region of positive grid potential. As such, even as Class C its operation is entirely unlike any other class of tube circuit design.

ENGINEERING ANALYSIS

(This section may be skipped by readers who dislike formulae.)

The D.C. power supplied to the rectifier diode (right section) by the power-oscillator (left section):

(1) $P_1 = I_b\ E_b$
where I_b = Average value of plate current (D.C.)
E_b = Plate voltage (D.C.)

The power output to the tank circuit L_1:

(2) $P_{tank} = E_p\ I_p = I_L^2 R_L$
where E_p = A.C. component of plate voltage (R.M.S.)
I_p = A.C. component of plate current (R.M.S.)
I_L = Circulating current in the oscillating circuit
R_L = Total resistance of the tank circuit plus the resistance reflected from the grid (acting as load) and load (L_2 with the associated rectifier circuit)

The power lost at the oscillator plate:

(3) $W_{dis.} = (1) - (2) = P_1 - P_{tank}$

The driving power for the oscillator stage:

British Combine Photo

Despite transport difficulties, the Western members of the United Nations are managing to supply our Eastern ally with some of the communications equipment so important to the successful conduct of modern war. The photo pictures one of these contributions, a car armored to meet battle conditions and completely equipped with the latest Occidental mobile radio direction-finding apparatus, so much needed in this war of communications.

(4) $P_s = E_g I_g$
where E_g = A.C. grid voltage (R.M.S.)
I_g = A.C. grid current (R.M.S.)

The power available for output:

(5) $P_o = E_p I_p - (E_g I_g + R_d)$
where R_d = Resistance of the detector circuit acting as load through L_3

Ignoring the inherent and unmeasurable losses in the oscillator and associated circuit, the efficiency of this stage:

$$(6)\quad Eff = \frac{P_o}{P_i} = \frac{E_p I_p - (E_g I_g + R_d)}{I_b E_b}$$

This stage is nothing but a half-wave rectifier, known to all students of radio as a means of producing direct current power from an A.C. source. It is called a detector in this case to differentiate it from the usual rectifier operating off the 117-volt primary A.C. lines.

Inspection of the circuit (right half of circuit diagram Fig. 1) will reveal components arranged much like the typical diode detector in a modern superheterodyne. In the radio receiver the detector removes the modulation peaks of the modulated R.F. carrier, thus demodulating the received wave. The removed modulation is passed on to a device which thus actuated produces sound. In the detector shown here, however, the removed peaks occur at the same carrier frequency . . . . There is no modulation. Therefore, the output is a series of peaks occurring at regular intervals and having the *same amplitude*, as shown in Fig. 2. These removed peaks are passed on, not to operate earphones, but to act as pulses of energy like charges of a generator to supply a source of direct current.

No. Wire	*Turns for Max. Milliwatts*
20	12
24	13
27	15
30	18
33	20

Fig. 4

The rectified D.C. output pulses of current charge the load by-pass condenser C_6 to nearly the same voltage as that across the transformer secondary L_2. Since the condenser stores the charge it tends to bias the tube between peaks, permitting the diode to conduct only when the input voltage is greater than the stored D.C., that is, only at peaks. In this respect, the stage operates Class C (if a diode can be considered as Class C). The charge, replenished at each pulse, is drawn from this stage by the load circuit, such as radio receiver, photo-electric cell, or other electronic equipment. The load is represented in the diagram Fig. 1 as a phantom resistor, R_2. The D.C. available for the load is that across the condenser C_6. The choke RFC keeps the high frequency out of the load.

The capacity of the condenser C_6 must be such as to offer minimum reactance to the input frequency, effectively filtering the D.C. output.

The condenser C_5 tunes L_3 to the resonant frequency, thus permitting maximum transfer of power, adding more voltage due to "resonant rise of voltage."

Since the duplex tube in the circuit is to function as rectifier it must be selected with the usual check on maximum peak inverse voltage rating. In the half-wave rectifier design the tube should be able to stand a voltage of 2.83 E_s, where E_s = voltage across L_2. In conservative design, assuming an output of 90 volts D.C., the tube would stand a maximum peak inverse voltage of 254.7 volts. The 25A7, for example, can stand this voltage, and is rated to deliver up to 125 volts D.C. from the rectifier section. If two separate tubes were used instead of a duplex tube, the voltage output might be raised considerably.

With an output of 90 volts D.C., the rectifier would provide about 6 milliamperes output to the load. (See Fig. 3 for rough approximation.) This is sufficient to operate most small electronic equipment, with the possible exception of a power tube to drive a speaker. In this case either a very small P.M. speaker should be used, or headphone operation should be incorporated. In the event that strong speaker operation is required, a 28D7 may be used as power amplifier, operating directly off the 24-32 volt storage battery. This should provide sufficient output. For the design of such a stage see the June issue of *Radio-Craft* under the title, "A 28-Volt Receiver."

The fundamental frequency of operation of the power-oscillator should be from 4 to 10 megacycles, depending on the design of the load coil L_3, which slides inside L_1 L_2. The plate and grid coils are wound on the same form, and are identical. Fig. 4 shows the Load Coil (L_3) table listing the wire gauge (B & S) and the number of turns necessary for maximum power output in milliwatts. With a 1 inch (outside diameter) low loss coil, about an inch or two long, referring to Fig. 4 wind the load coil for your particular application. Cement it with a good h.f. binder or wind it tightly.

Since the load coil slides inside the primary, it is necessary to allow sufficient inside diameter in the primary coil to accommodate the load coil. For the primary use a ceramic coil form about two inches in length with a nominal inside diameter of ½ to ¾ inch. (If a selection is available, select a form which will permit the load coil when wound to be pushed into position to stay there by friction.) The plate and grid coils should be wound in the same direction, ⅛ to ¼ inch apart, using 10 turns of No. 14 wire, closewound, for each winding. This will correspond to a frequency between 4 and 10 megacycles. The exact frequency need not be known, since the only tuning involved is for greatest energy transfer, which once set will not be changed. Condensers C_1, C_2 and C_5 tune their respective coils to the required frequency. This will have to be done with an insulated screwdriver, judging resonance by noting the reading of a voltmeter in the output circuit. Maximum voltage is the best setting.

The optimum value of the grid-leak R_1 should be found experimentally, since it varies for each coil and with the load, generally being between 200 and 5000 ohms.

In designing the power-oscillator it is important to base the data on the highest no-load voltage to be encountered, since the voltage will rise with reduced load. Thus the output voltage varies inversely as the load, as shown in the regulation graph Fig. 3. With a fairly fixed load the output should be essentially constant. The regulation might be somewhat improved with a power-supply filter, but this will reduce the output somewhat.

If a stable load coil is desired without experiment, wind L_3 with 60 turns No. 30 wire. The coil form will be longer than one inch, but will require very little adjustment.

The author wishes to acknowledge his indebtedness to SYLVANIA NEWS *for the data from which this article was prepared.*

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ELECTRONIC TUBE SYMBOLS

(Continued from page 672)

to indicate which tube base pins are connected to each of the tube's elements.

Because of the diversity of types of drawings required on various blueprints to indicate a given tube, it follows that a graphical tube symbol is a cross between a pictorial portrayal of the tube and a symbolic semi-wiring diagram of the tube itself.

At present we are concerned only with representative drawings of tube elements as they appear on a graphical symbol within the glass or metal vacuum envelope of the tube itself.

This envelope is usually indicated by a circular or oval outline and the leads from each element are carried through this circle into the wiring of the schematic itself. It is not customary procedure to indicate on the schematic that the tube is either metal or glass.

Many engineers, in drawing rough circuits, or to illustrate a point during discussions, will leave the enveloping circle of the tube's case off entirely, but in drawing a schematic to be used for production or design it is best to encircle the tube elements to avoid confusion.

As any tube will contain at least two elements and even the most complex will be confined to grids, plates, cathodes and heaters in various quantities and positions, a primary requisite is the ability to identify each tube element as shown in the symbol.

The "heaters" are usually drawn with no direct connections to their cathode. Standard methods of showing heaters are given on this page. Cathodes used in conjunction with heaters, and directly heated cathodes are also shown (Fig. 1-a).

Plates (anodes) may be drawn in any one of several ways but the illustrations given here are customary methods of representation. The commonest of these are shown in Figs. 1-b and 1-c.

A gas tube is always drawn with a distinguishing dot or circle within the tube outline and pilot lights or neon bulbs are drawn in such manner that confusion is impossible.

When tube elements are connected within the tube the symbol is drawn as indicated in Fig. 1-d, but if elements are inter-connected outside of the tube's envelope, even if the inter-connections are in the pins, they must be drawn external to the tube symbol, as in Fig. 1-e.

Television tubes are in a class by themselves. An example of a symbol for a television tube is shown in Fig. 2. The elements of these tubes, while similar to those of receiving and transmitting tubes, serve different purposes. Consequently the drawing of graphical symbols for television tubes should be treated and studied as a separate subject.

In graphical tube symbolism, as in all schematic drawings of radio circuits, the important thing is to standardize. Standardization of all graphical symbols and of tube symbols in particular will repay the radio engineer, draftsman or technician a hundredfold in eliminated errors and in quicker, more ready interpretation of schematic drawings.

TANK SPEAKER IS SMALLEST YET

THE "smallest loud-speaker yet," mentioned in the editorial, "Shrinking Radio" (*Radio-Craft*, January, 1944), has aroused some interest, and even slight doubt.

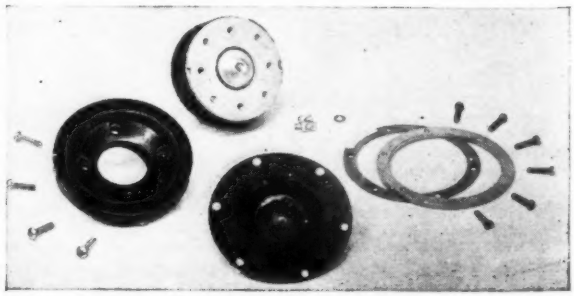
The loud-speaker actually does exist, as the illustrations show, and it is no freak or toy gadget. On the contrary, this is a rugged unit designed for the toughest imaginable kind of use. Its main application is in tank radios, than which no more rugged service can be imagined.

Its dimensions, as given in the original editorial, may have been measured a little liberally; rather than otherwise. The actual size is graphically shown in the photograph, by comparison with an ordinary match folder.

This sturdy little PM is a standard Magnavox speaker. The voice coil, unexpectedly, has a resistance of 50 ohms. The "pot magnet" is made in two pieces, as is shown by the ends of four screws in the breakdown photo. Over the magnet is placed a bakelite ring, on which the cone is placed. The cone itself is made of bakelite-impregnated cloth, and is almost as strong as any other part of the unit. Repeated thrusts with an index finger, driving the cone back against its support, succeeded only in producing a few cracking noises, but did no visible damage to the fabric.

The audio qualities of this little speaker are improved by careful design of the pole piece and the air space under the cone as well as in the "dust cap" at its center. Voice coil leads are brought out through the two grooves in the edge of the bakelite ring, visible at the left edge of the break-down photo.

It would be interesting to know what the designers of the original Magnavox—which stood more than two feet high and was a fair load for a serviceman—would have thought if they could have seen how their product would be transformed in 25 years. True it is that radio is shrinking in the cumbersomeness of its apparatus as it is expanding in power, range and universal use!



REMOTE CONTROL WEAPONS *(Cont. from page 649)*

sees—in all six directions—is radioed back to headquarters where observers view the six-image screen as the plane proceeds on its course If another plane or planes approach from any point, the distant radio-control officer can put the plane through evasive tactics and elude the pursuers. The plane can even be equipped with guns, which can be fired by remote control as desired. After the television plane has negotiated the various war hurdles and evaded interception flak, etc., it can then discharge its bombs on the target, or (if necessary) the plane can carry a single large load of explosive which is detonated on contact—blowing up the plane itself, should this be desired. If the plane is to be saved, it could drop bombs in the manner of present-day bombers, and then return to its base—all by radio-control.

All this is not an impossible picture and you may be sure that long distance robot military planes of this type will be in use in the future.

One thing about them—they most likely will not be used to terrorize the population and kill people needlessly as the Nazi robots are doing now. In war, whenever possible, every High Command prefers to use weapons for purely military purposes.

EARLY NOISE-REDUCING MIKES

ANENT the noise-reducing microphone and its inception, concerning which we published a letter from Benjamin F. Miessner a short time ago, *Radio-Craft* has received the following letter from Mr. Peter L. Jensen. Mr. Jensen was at the time Chief Engineer for Magnavox, mentioned in Mr. Miessner's letter as having also been engaged in anti-noise microphone research at that time:

Dear Mr. Gernsback:

I read with interest the letter from Benjamin F. Miessner addressed to you and published in *Radio-Craft* for March, 1944, under the heading, "Anti-Noise Mike Not New." Also in the same issue, on page 348, is published a short report which testified to the success of the anti-noise microphones used on the flight of the NC-4, the first airplane to cross the Atlantic Ocean. The report, mentioning the superiority of this type of mike, was written by Lt. Commander Lavender, who made the flight himself as the officer in charge of communications.

Benjamin Miessner's statements are substantially correct as far as I know, but for the sake of history, and in order to keep the records clear, may I be permitted to contribute some additional information on this subject?

Shortly after the United States entered the first World War, Lt. Commander Sweet, who was well known to all oldtimers as one of the Navy's first radio experts, approached Pridham and me with the suggestion that our powerful dynamic loudspeaker might possibly solve the problem of intercommunication between the crew members on an airplane.

We were fortunate to have the Hall Scott Motor Company's plant practically in our backyard, in Oakland, California, and we made our preliminary tests alongside airplane motors which were being tested on blocks and which ran day and night. The noise level close to these motors was as high as in any airplane. We quickly discovered that altogether too much noise entered our microphone and that our puny little human voice was completely unintelligible in the loudspeaker. The problem, therefore, became a microphone problem and we developed in a short time the so-called anti-noise microphone. We stripped the mike of all enclosures in order that the motor noise might be permitted to impinge upon both sides of the diaphragm and thereby neutralize itself, whereas the voice, which impinged upon one side only, alone actuated the mike. Speech with this new mike was reproduced with great clarity and without the disturbing intermingling of thunderous motor and wind noises.

A patent was filed on the new mike and the application was placed on the secret list in the Patent Office. Some time later the patent was declared in interference with an application filed by Benjamin Miessner, but as the Magnavox Company, to whom the patent was assigned, was then the only concern in the country producing this new lip mike, a deal was made with Miessner in order to avoid costly interference proceedings and the basic original patent was issued to us. The interference case never proceeded to the point where date of conception and first date of reduction to practice was determined. The Magnavox Company, where Pridham and I jointly held the title of chief engineer, was the sole manufacturer of anti-noise lip microphones during the first World War. The Magnavox type became the standard mike for all Navy airborne equipment during the war and for some time afterwards, including the period when the NC-4 flew the Atlantic. Concurrently, we developed an anti-noise mike, based on the same principle, for use with ship telephones where noisy engine rooms and other conditions had been a problem. The ship telephone which we developed employed a permanent magnet dynamic telephone, also a new innovation, and coupled with an anti-noise microphone the instrument performed so outstandingly well that it was adapted for use on nearly all Shipping Board's vessels as well as on all the two hundred and fifty four-stack destroyers of that vintage.

Shortly after the war, radio burst on us like a tidal wave and all our energies became concentrated on loudspeakers. The developments on lip microphones were shoved into the background and remained dormant, as far as I know, until the beginning of the present war. However, I have always thought that the anti-noise principle might become important in certain commercial telephones.

I am sure my good friend, Pridham, is not interested in asking for glory for having originated the principle embodied in the anti-noise lip mike any more than I am. Our country has been good to both of us, and whatever recognition has been given us has come to us for work in another field. However, as microphone and loudspeaker consultant to the War Production Board, I personally salute the Electrovoice Corporation in South Bend for the good work they have done in bringing the lip mike to such a high state of perfection. My only concern is that the Corporation is not reducing their very large backlog of orders for lip mikes fast enough.

Sincerely,

PETER L. JENSEN

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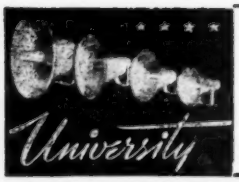

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not be calculated by simple Ohm's law, but is usually given in graphs on the technical data sheets or in the tube manuals.

In Fig. 3 we have a rectifier with a voltage of 400 applied to it and a load with a resistance of 35,000 ohms. The load draws 10 milliamperes, and the voltage across it is 350. The rest of the drop (50 volts) is inside the tube, between the plate and cathode. If we drop the resistance of the load to 3,000 ohms, the voltage across it drops to 300 and the current rises to 100 milliamperes. In this case, the tube has acted as a fairly *linear* device, voltage rising with current very much as in an ordinary resistor. This might not have been the case had our load been a capacity instead of a resistance. In such a case, we might expect to find about 510 volts D.C. output with our 400 volts A.C. input, and a much sharper drop in voltage with increased current than we should expect from Ohm's law.

This increased voltage drop with increased current is important for two reasons. It acts as a safeguard for the tube should excessive voltages be put on it, or if (because of short-circuits or any other reason) the resistance of the output circuit (load) is unduly decreased. We have in effect an additional resistor in our circuit. This opposes any increase in current, thus preventing that increase from becoming as great as it would otherwise have become. The resistor action of the tube thus often saves it from being destroyed when some part of the apparatus to which it is attached breaks down and subjects it to an overload.

The second important feature of the tube's resistance is that such a tube causes some loss of power in any circuit in which it is inserted. When large amounts of current are to be rectified a high-vacuum tube becomes uneconomical. Transformers must supply enough voltage to make up for the high internal drop in the tube as well as the drop in the load, and large amounts of electricity are wasted in heating up the anode. The gas-filled tube delivers large output currents with little loss. It shows no such increase in resistance with increased current as does its high-vacuum brother (and consequently does not act as a safety device in its own circuit).

Current flow in a gas tube depends—as we have learned—on breaking down, or ionizing, the atoms of gas which compose its atmosphere. This occurs at a definite voltage for each gas, less than 20 volts for gases commonly used in rectifiers. Below that voltage, little or no current flow takes place. When it is reached, the gas ionizes, and the positive ions attract large numbers of electrons away from the cathode. If the load resistance is reduced or the input voltage increased, more atoms are ionized and more current flows, but the voltage between cathode and anode remains the same, within the normal operating ratings of the tube.

Electron-tube rectifiers which must supply heavy currents are almost invariably of the gas-filled type, for the reason that such tubes will supply large amounts of electricity at high efficiency. Because of that very feature they are much less rugged than the high-vacuum type and must be operated with greater care.

Heavy peak currents have a dangerous effect on the gas-filled tube. Should the current rise beyond the rated peak, the voltage drop across the space between cathode and plate will start to increase. As this happens, the ions, attracted by the negative voltage on the cathode, start moving toward it. Meeting with no electrons to neutralize their positive charges, they rush into the cathode and bombard it in an ionic hailstorm. These ions have enough weight, and—speeded up by the increased voltage attracting them—enough velocity to strip the active coating from the cathode surface ruining the tube. *Arc-backs* when the cathode is positive may have the same effect. In that case the electrons, speeded up by the high inverse voltage, do the bombarding.

The cathode may also be stripped if the tube is operated at too low temperatures. Many gas-filled tubes use mercury-vapor as their atmosphere. A few drops of ordinary metallic mercury are put in the tube during manufacture. The mercury is vaporized by the heat of the cathode. If the high voltage is applied while the tube is warming up, we have a situation similar to a voltage overload. The cathode is not able to emit as many electrons as when fully heated, and the atmosphere in the tube is less dense than required to maintain the low voltage drop between cathode and plate. As this internal voltage increases, so does the attraction of the cathode for the

The original walkie-talkie

positive ions, and so does their speed as they rush toward it. An ion is like an automobile—when it strikes an obstacle, its destructive force is proportional to its speed. It is necessary to use two switches for turning on a gas-rectifier power supply, one to light the filaments, (heaters or cathodes) and the other, (often automatically operated) to turn on the anode voltage when the tube is properly heated and the mercury vaporized.

Operation at too high temperatures also has its dangers. Since the atmosphere in the usual gas tube is created by the evaporation of mercury, as the temperature goes up that atmosphere becomes denser. This reduces the voltage at which *arc-back* will occur. In many cases it causes the tube to act as a cold-cathode rectifier, carrying small currents on the half of the A.C. cycle when the plate is negative.

The inverse peak voltage must also be more carefully watched with gas-filled than with high-vacuum tubes, and the possibility of high-voltage surges in the supply current carefully considered.

Another gas-tube rating which may seem puzzling is the *maximum averaging time*. This is merely the average current rating, with a safeguard added. A tube may have an average current rating of 1 ampere, and be used in the application where it is working only 20% of the time. Yet the same tube might be ruined if 5 amperes were drawn from it for 1 minute and none for the next 4 minutes. The one-minute drain at five times normal current might be quite sufficient to cause damage. In other words, 5 minutes is too long a time over which to take an average. The usual averaging time is 30 seconds, which would mean in this case that the tube could deliver 5 times normal current for 6 seconds if it remained idle for the next 24.

The very weaknesses of gas-filled rectifiers are due to its greatest virtues—large current-delivering ability and low internal loss. It is therefore not surprising to find them used almost universally where a simple rectifier is needed to deliver large currents at modern voltages. Where extremely high voltages are required, efficiency is sacrificed, and high-vacuum tubes used. Where output currents and voltages have to be controlled, more complicated gas rectifiers, such as the Thyratron and the already-mentioned Ignitron, are used. They will be described in the next lesson.

SYSTEM AND SERVICING

OUR millions of people depend entirely upon the radio serviceman for the maintenance of their most extensive source of entertainment and news, the broadcast receiver. With all the priorities and shortages the serviceman is left at somewhat of a loss. This should present itself as a challenge, however, and the serviceman should have at his disposal the necessary initiative to cope with the remote conditions under which he is forced to work. Due to these difficult situations, the radio repair man is no longer a serviceman, he is viewed as a radio maintenance technician, because he may sometimes have to redesign or reconstruct in order to affect a repair.

When we consider that now many servicemen are beginners in the field, their difficulties are greatly increased. The new serviceman must turn his efforts in two directions—to understand thoroughly the schematics of modern receivers, and the functions of the single circuits of which these receivers consist. With this knowledge he will be able to proceed to the first important step in servicing—*locating* the circuit, stage and part in which the defect is concealed.

The next thing is to learn to use the most effective of the methods of locating trouble: point to point testing; substitution; circuit analysis; or the use of signal tracers and the cathode-ray oscilloscope. All these have been covered in *Radio-Craft* articles.

Out of these four methods available, the serviceman should use the method or methods which most rapidly and accurately aid him in localizing the trouble. With a small amount of study and practice, he is sure to find many *additional uses* for his available equipment, heretofore not realized. He develops a mania for knowing the ins and outs of his test equipment. He should also be readily familiar with the *theory* behind the circuits with which he is working, or else his test equipment is practically useless. This statement cannot be overemphasized.

After the serviceman is aware of the methods available to him, the next step is to correlate the procedure to follow. These procedures vary widely with situations and equipment, but four major steps are to be followed for the maintenance of electronic equipment:

(1) Check the power supply and its adjacent equipment.
(2) Localize the trouble within the set.
(3) Determine the cause of the trouble.
(4) Determine and effect the remedy.

These steps are self-explanatory, and should not require too much discussion or portrayal.

Keep a notebook handy at the test bench in which three columns may be tabulated. First, the model number of the set serviced should be entered for identification; second, the symptoms which prevailed; and third, the replacement or adjustment which was necessary to effect a repair. It is quite true that there are many commercially published "Trouble Shooter Manuals," but nonetheless, all the symptoms and troubles one set alone would have, could not be covered in a large volume of manuals. For this reason, the servicing notes kept at the bench will repay the effort made in collecting them.—*J. M. K.*

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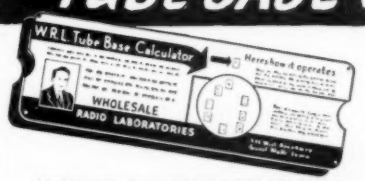

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ELECTRONIC VULCANIZER

AN electronic tire-vulcanizing device employing electronic principles, which would enable major tire repairs to be made in 10 minutes in combat zones and which promises to become a factor in extending the service life of post-war tires to 100,000 miles, was announced at SAE National Transportation & Maintenance Meeting in The Bellevue-Stratford

The 500-pound mobile military unit is designed to effect repairs on any tire and replace Army tire-repair equipment weighing tons and taking hours to operate.

The device, consisting of a press ram equipped with an electrode coupled to a high-frequency generator, and a press frame, applies "internal heat" to make spot and sectional cures within minutes. The ram and frame, fitted with filler bags which adjust themselves under pressure to tire contours, obviate the use of molds, effect repairs on any size tire, and eliminate current vulcanizing hazards such as destructive over-heating of adjacent sections. Like other electrostatic generators, this vulcanizer works from the inside out, keeping heat on the parts treated.

Tests were said to indicate the possibility of utilizing the principles of the device after the war both for recapping and for new tire production operations.

WORLD-WIDE STATION LIST

(Continued from page 671)

11.710	WLWO	CINCINNATI, OHIO; European beam, 2:45 to 5:15 pm.
11.718	CR7BH	MARQUIS, MOZAMBIQUE.
11.720	CJRX	WINNIPEG, CANADA.
11.720	PRL8	RIO DE JANEIRO, BRAZIL; "Radio Nacional"; 9:35 to 10:45 pm; off on Sundays.
11.725	JVW3	TOKYO, JAPAN; 9 am to 2:40 pm.
11.730	GVV	LONDON, ENGLAND; heard at 9 am and 12:45 pm to India.
11.740	WRUL	BOSTON, MASSACHUSETTS; Mexican beam, 7:30 pm to 2 am.
11.740	COCY	HAVANA, CUBA; 11 am to 1 pm.
11.750	GSD	LONDON, ENGLAND; afternoons.
11.77	DJD	BERLIN, GERMANY; evenings.
11.775	——	SAIGON, INDO-CHINA; 10 to 11:30 am.
11.775	MTCY	HSINKING, MANCHURIA; 1.30 to 3 am.
11.78	GVU	LONDON, ENGLAND.
11.780	HP5G	PANAMA CITY, PANAMA; 9:45 pm to ?
11.790	WGEX	SCHENECTADY, NEW YORK; European beam, 1:45 to 4:45 pm.
11.790	——	RADIO PRAHEVA.
11.79	KGEI	SAN FRANCISCO, CALIFORNIA; 5 pm to 12:45 am, South American beam.
11.790	WRUA	BOSTON, MASSACHUSETTS; North African beam, 1:45 to 4:30 pm.
11.80	JZJ	TOKYO, JAPAN; 11:45 pm to 1:15 am.
11.800	HI3X	TRUJILLO CITY, DOMINICAN REPUBLIC; afternoons.
11.805	COBH	HAVANA, CUBA; afternoons.
11.81	2RO22	ROME, ITALY.
11.820	GSN	LONDON, ENGLAND; afternoons and evenings.
11.820	CXA11	COLONIA, URUGUAY.
11.820	XEBR	HERMOSILLO, MEXICO; afternoons.
11.830	WCRC	NEW YORK CITY; West South America beam, 5:30 pm to midnight; European beam, 7 am to 5:15 pm.
11.840	COBH	HAVANA, CUBA.
11.845	——	VICHY, FRANCE; 4 to 4:30 pm; evenings to 10:15 pm.
11.847	WGEX	SCHENECTADY, NEW YORK; European beam, 6 to 11:45 am.
11.847	WGEA	SCHENECTADY, NEW YORK; European beam, noon to 4:45 pm; Brazilian beam, 5 to 8:15 pm.
11.855	DJP	BERLIN, GERMANY.
11.86	ZPA6	VILLARICA CITY, PARAGUAY; news in Spanish at 8 pm.
11.86	GSE	LONDON, ENGLAND.
11.870	WBOS	BOSTON, MASSACHUSETTS; European beam, 5:45 to 7:30 am.
11.870	WOOW	NEW YORK CITY; European beam, 7:45 am to 5 pm.
11.870	WNBI	NEW YORK CITY; East South America beam, 7 pm to midnight; Sundays only, 7:45 pm to midnight.
11.88	VLR3	MELBOURNE, AUSTRALIA; 1 to 3:15 am.
11.88	LRR	ROSARIO, ARGENTINA; heard evenings; news in Spanish at 6:30 to 6:45 pm.
11.893	WRCA	NEW YORK CITY; European beam, 5 to 9:45 am; 3 to 4:45 pm.
11.895	CXA10	MONTEVIDEO, URUGUAY.
11.900	XGOY	CHUNGKING, CHINA; Allied Forces in the Far East beam, 8 to 9 pm; Asia-Australian-New Zealand beam, 6 to 6:30 am; East Russia beam, 6:30 to 7 am; Japan beam, 7 to 7:30 am.
11.900	KWIX	SAN FRANCISCO, CALIFORNIA; Australian beam, 1 to 7:58 am; 4 to 7:30 pm.
11.905	——	UNITED NATIONS RADIO—ALGIERS.
11.910	2RO	ROME, ITALY.
11.948	——	MOSCOW, USSR; 8:45 to 9 am.
11.950	KKQ	SAN FRANCISCO, CALIFORNIA; works with KRO2, Honolulu, afternoons and evenings.
11.970	FZI	BRAZZAVILLE, FRENCH EQUATORIAL AFRICA; "Radio Brazzaville."
11.975	——	RIO DE JANEIRO, BRAZIL; "Radio Nacional" heard at 10 pm.
11.98	——	LONDON, ENGLAND; 5:15 to 8 pm.
12.000	——	LISBON, PORTUGAL; Oriental beam, 8 to 10 am.
12.000	——	SINGAPORE, STRAITS SETTLEMENT; "Radio Shonan."
12.040	GRV	LONDON, ENGLAND.
12.060	FFZ	SHANGHAI, CHINA; heard at 8 am.
12.070	CSW	LISBON, PORTUGAL; 9:30 to 10 am.
12.110	HI3X	TRUJILLO CITY, DOMINICAN REPUBLIC; 5 pm.
12.115	ZNR	ADEN, ARABIA; off at 1:15 pm.
12.235	TFJ	ICELAND; Saturdays, 10 to 10:30 pm.

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RECEIVER HEADQUARTERS
for the Nation

BEFORE the war Bob Henry served the amateurs as the world's largest distributor of communications receivers.

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★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

12.27	COCB	HAVANA, CUBA; daytimes.
12.445	HCJB	QUITO, ECUADOR; "Voice of the Andes"; 5 to 11 pm; off Mondays in English at 10 pm.
12.967	WKRD	NEW YORK CITY; European beam, 1 to 6:30 pm.
12.967	WKRX	NEW YORK CITY; North Africa beam, 6 to 8 am.
13.000	HDD	QUITO, ECUADOR; heard calling LSX in early evening.
13.085	COCH	HAVANA, CUBA; afternoons.
13.22	ICA	ALLIED HEADQUARTERS IN ITALY; Sundays only, 3 pm.
14.10	——	DAKAR, FRENCH WEST AFRICA; Sundays, 2:45 to 5 pm.
14.460	DZH	BERLIN, GERMANY.
14.480	——	EL SALVADOR.
15.000	WWV	WASHINGTON, D. C.; United States Bureau of Standards; daytimes only.
15.070	GWC	LONDON, ENGLAND; 10 to 11 am.
15.105	JLG4	TOKYO, JAPAN; 2 to 4 am; heard some evenings.
15.11	DJL	BERLIN, GERMANY.
15.11	——	MOSCOW, USSR; 9:15 pm and 11:15 pm; 5:15 to 5:40 pm.
15.120	——	"SENDER ATLANTIC"; heard in afternoons and evenings.
15.130	DXR7	BERLIN, GERMANY; on at 8:30 am.
15.130	DXL6	BERLIN, GERMANY; heard at 4:30 pm.
15.130	WRUS	BOSTON, MASSACHUSETTS; North African beam, 4:45 to 6 pm.
15.140	GSF	LONDON, ENGLAND; 10 am to 4 pm.
15.150	WRCA	NEW YORK CITY; Brazilian beam; 5 to 7:45 pm.
15.150	WNBI	NEW YORK CITY; European beam; 7:45 am to 3:30 pm.
15.155	SBT	STOCKHOLM, SWEDEN; 7 to 7:55 am; 11 am to 2:15 pm; Sundays only, 4 to 11 am; noon to 2:15 pm.
15.165	PRE9	FORTALEZA, BRAZIL; 6 to 7 pm.
15.170	TGWA	GUATEMALA CITY, GUATEMALA; daytime transmissions.
15.190	KROJ	LOS ANGELES, CALIFORNIA; Oriental beam, 2:30 to 8:45 pm.
15.190	WOOC	NEW YORK CITY; European beam, 7:45 am to 5 pm.
15.20	DJB	BERLIN, GERMANY.
15.210	WBOS	BOSTON, MASSACHUSETTS; European beam, 7:45 am to 5:15 pm; East South America beam, 5:30 to 8:15 pm.
15.220	——	"NATIONAL CONGRESS RADIO" (INDIA); heard at 12:15 pm.
15.220	——	"VOICE OF FREE INDIA."
15.225	JTL3	TOKYO, JAPAN; 6:15 to 8:15 pm.
15.230	WKRX	NEW YORK CITY; Central Africa beam, 4:15 to 5 pm.
15.230	——	MOSCOW, USSR; off at 7:25 pm.
15.230	WKRD	NEW YORK CITY; Central Africa beam, 6 to 8 am; North Africa beam, 9:15 to 9:45 am; South Africa beam, 10 to 10:30 am.
15.230	VLG6	MELBOURNE, AUSTRALIA.
15.240	TPC5	VICHY, FRANCE; 11:15 am to 1:30 pm.
15.250	WLWK	CINCINNATI; European beam, 8:15 am to 5:15 pm; West South America beam, 5:30 to 8:15 pm.
15,260	GSI	LONDON, ENGLAND; African beam, 11 am to 5 pm.
15.270	WCBX	NEW YORK CITY; European beam, 7 am to 4:45 pm.
15.290	KWID	SAN FRANCISCO, CALIFORNIA; South American beam, 1 to 9 pm.
15.300	2RO	ROME, ITALY.
15.31	GSP	LONDON, ENGLAND.
15.315	VLQ3	SYDNEY, AUSTRALIA; news, 1:15 to 1:30 am.
15.320	JFY	TAIHOKU, JAPAN.
15.330	WGEO	SCHENECTADY, NEW YORK; European beam, 7 am to 3:30 pm; 3:45 to 5:15 pm.
15.350	WRUW	BOSTON, MASSACHUSETTS; European beam, 2:45 to 6 pm.
15.350	WRUL	BOSTON, MASSACHUSETTS; North African beam, 10 am to 1:30 pm; European beam, 1:45 to 2:30 pm.
15.355	KWU	SAN FRANCISCO, CALIFORNIA; Oriental beam, 7:45 to 9:30 pm; off on Wednesdays; Sundays only, 4:45 to 6:15 pm; South America beam, 11 am to 2 pm.
15.370	ZYC8	RIO DE JANEIRO, BRAZIL; 10 am to noon; also evenings.
15.400	GRE	LONDON, ENGLAND; heard in afternoon.
15.410	PZP	PARAMARIBO, DUTCH GUIANA.
15.410	RW96	MOSCOW, USSR.
15.420	GWD	LONDON, ENGLAND; 11 am to noon.
15.45	GRD	LONDON, ENGLAND; heard till noon.
15.465	2RO24	ROME, ITALY.
15.750	——	MOSCOW, USSR; heard mornings.
15.810	LSL3	BUENOS AIRES, ARGENTINA; during mornings.
16.000	EPA	TEHERAN, IRAN; operated by AFHQ; heard Sunday 4:12 pm.

(Continued on next page)

(Continued from previous page)

16.025	AFHQ	ALLIED HEADQUARTERS, NORTH AFRICA.
17.72	LRA5	BUENOS AIRES, ARGENTINA; "Radio del Estado"; Fridays, 5 to 5:30 pm.
17.750	WRUW	BOSTON, MASSACHUSETTS; Central America beam, 7:30 to 9:15 pm.
17.760	KROJ	LOS ANGELES, CALIFORNIA; Australian beam, 9 to 10 pm.
17.760	WKRX	NEW YORK CITY; Central Africa beam, 10:45 am to noon; 1:30 to 4 pm; South African beam, 1 to 1:15 pm.
17.773	OTC	LEOPOLDVILLE, BELGIAN CONGO.
17.780	WRCA	NEW YORK CITY; European beam, 10 am to 2:45 pm.
17.780	WNBI	NEW YORK CITY; East South America beam, 5:30 to 6:45 pm; Sundays, 5:30 to 7:30 pm.
17.800	WLWO	CINCINNATI, OHIO; European beam, 8 am to 2:30 pm; West South America beam, 5:30 to 6:45 pm.
17.800	TGWA	GUATEMALA CITY, GUATEMALA.
17.830	WCDA	NEW YORK CITY; European beam, 8:15 am to 3 pm.
17.870	GRP	LONDON, ENGLAND; African service, mornings.
17.880	WGEX	SCHENECTADY, NEW YORK; European beam, noon to 4:45 pm.
18.000	KRO2	HONOLULU, HAWAII; afternoons and evenings; with KKQ, San Francisco.
18.000	NGK4	Heard calling San Francisco for relay broadcast.
18.135	YDA	BATAVIA, JAVA; 10 to 10:50 pm, beam, in French, 1:55 am; British beam, 3 am.

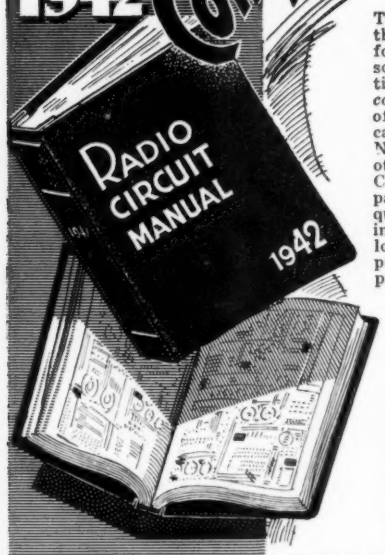
●

Mine detectors have been employed on the invasion front to ferret out snipers. Germans hid in small pits with sod-covered trapdoors. They could not be found by ordinary methods, but the mine detectors had no difficulty in registering the "buried treasure" represented by the sniper's rifle, helmet and other metal accoutrements.

RADIO CIRCUIT MANUAL 1942

UP-TO-DATE OF GOVERNMENT SHUT-DOWN APRIL, '42

Complete, Correct, Compact



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☐ Kindly send C.O.D. I enclose my deposit remittance of $..... (20% required).

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LIMITED NUMBER OF 1941 MANUALS LEFT

Our 1941 RADIO CIRCUIT MANUAL—the first we ever issued—proved so popular that we cleared out most of them in a short time notwithstanding a large printing. However, during a recent inventory, we discovered a small number still on hand which we are disposing of quickly. This should be good news to anyone who failed to get the 1941 edition. After all, many 1941 models must be served today, and the 1942 edition won't help at all for the earlier models. The price of the 1941 edition is the same as 1942 . . . . only $10.00 each

ELECTRONICS STUDIES SNAP

WHY stretched rubber bands snap back to their original lengths, and why rubber balls bounce, are now better understood scientifically, as a result of studies made on the properties of rubber by use of the electron microscope. Visual evidence now proves the correctness of former theoretical suppositions.

Natural rubber, it has long been known, can be separated by suitable solvents into two parts called sol and gel. When the sol constituent is greater in a rubber mixture, it is more plastic or putty-like. When the gel is greater, it is tougher and more elastic. Vulcanizing converts much of the sol fraction into gel, thus making the material longer-wearing in such applications as tires.

The electron microscope reveals that the long, flexible molecular chains composing the rubber consist of two structures. The first consists of single threadlike filaments, along which are strung rounded nodules. Both thread and nodules are made up of rubber molecules. The sol fraction of natural rubber is largely of this type. The group of chains are bound by so little cross-linking that free slipping results and the nodules may be referred to as fluid.

The second structure is one in which the molecules form a highly branched network of filaments, criss-crossed and cross-linked along the meshed fibers of the mass. The molecules of these beads are packed far more closely than in the first type and therefore cannot slip about each other freely. The gel fraction is this second type of structure.

In these findings is electron microscopic explanation of why sol rubber is putty-like and plastic and why gel rubber is tough and springy. The free-slipping chains of the sol structure do not possess the linkages to pull them back to original shape; the tightly linked chains of the second structure resist displacement and return to shape.

Vulcanized rubber consists almost wholly of gel structures. In the production of tires natural rubber is milled or ground. The milling process breaks down the gel portion, increasing the sol portion, and bringing the whole nearer to a completely plastic or putty-like state for molding. The vulcanizing process which follows drives the loose sol portion back to the tighter gel state, increases the proportion of gel by decreasing the sol, giving a nonplastic, nonputty-like, elastic condition.

The studies were made at the Massachusetts Institute of Technology under the direction of Dr. F. O. Schmitt, who was assisted by C. E. Hall, E. A. Huser, D. S. LeBeau and P. Talalay.

●

A patent recently granted to Donald Hare of Houston, Texas, provides a method of determining the level of a liquid in a closed container by directing gamma radiation through the wall, detecting the radiation scattered by the liquid within the container, and raising or lowering the source of radiation and the detector till the precise level of the liquid is ascertained.

The patent was assigned to the Texas Co., and is believed to be of practical use in exploring the conditions outside the casings of oil-wells, the detector being raised and lowered inside the casing, to discover the level of water or oil in the area immediately outside it.

TECHNOTES

. . . . RCA VHR407

Complaint: When making recordings the record showed gaps between threads, especially toward the center of the disc.

The trouble was at first thought to be due to a thre[illegible] tangle which pulled the stylus to on[illegible]. The thread tangle was corrected, afte[illegible]ng several different cutting needles to a [illegible]vail, by filing the back edge of the rear crystal mounting plate on a 1° or 2° bias or angle (this bias angle can be determined by placing paper spacers of different thicknesses between the inner rear knife edge bearing which supports the crystal recording head), so that the stylus end of the crystal was turned slightly away from the center of the record, thus forcing the thread throw toward the center of the record instead of away from it. This eliminated the thread tangle but the gap still showed up in the same place on the recording An examination of the feed mechanism showed the presence of a blue dope (probably cellulose acetate or nitrate lacquer) on the threads of the lead screw at this point. This "dope" was also found on some other parts (especially the pick-up wires) of the mechanism.

A scraping and thorough cleaning of the lead screw eliminated the trouble.

R. S. Havenhill,
Josephtown, Pa.

. . . . CONVERTER SUBSTITUTES

When 12SA7's and similar types are unobtainable, it is often necessary to substitute other types. In many circuits the change results in oscillation or a loss of sensitivity and volume. When realignment and shielding do not solve the problem, the following procedure has been used successfully in many cases. Check all I.F. leads to be sure that they are well insulated and separated from supply leads and coupling condensers. Insert a resistor in the screen grid circuit. The exact size will vary from set to set and also with the tube used.

To substitute a type 12A8GT/G for a type 12SA7 in an RCA Model 46-24 requires the following changes. Disconnect the lead from the No. 8 prong on the socket and run it to the topcap of the 12A8GT/G. Disconnect all leads from No. 6 prong on the socket and connect them to No. 8 prong. Connect No. 6 prong to No. 4 prong. If the anode grid is left floating it often assumes a negative charge and causes distortion. Realign and use a tube shield if necessary. If oscillations persist, insert a ½ watt 30,000 ohm resistor in the screen grid circuit and realign.

John B. Parchman,
Emporium, Penna.

. . . . TESTING 1.4 VOLT TUBES

When testing 1.4 volt tubes (.15 amps series) in the average tube tester, it is usually found that the 1½ volt tap really gives 2 volts or more, since it was designed to test 26 types which have a 1 ampere load. The high voltage may damage the small tube filament.

This difficulty may be corrected by using an old 26 tube as load ballast, clipping off all prongs but the filament. It is also possible to use 27, 24 or 35 types for this purpose.

F. E. Feiner,
St. Louis, Mo.

. . . . A JUSTIFIED COMPLAINT

In your Serviceman's corner, could you not include some *more explanation* of the remedies for particular set complaints. For instance, when you say, "Philco TH-18, weak, fades—replace volume control," there is no apparent connection between the trouble and the remedy.

A simple test for assuring oneself that it really is the volume control, as well as clues leading one to suspect it in the first place, would be generally useful.

Pvt. Joseph Silver,
Camp Crowder, Mo.

. . . . GTC PORTAPOWER MOD. L
(for 2 volt radios)

These units generate more than two volts and directions state that a resistor should be installed in the filament lead as in Fig. 1, its value depending upon the drain.

The one drawback is that the filter condenser is rated at three volts and the actual voltage across it may have any voltage of from three to five volts across it, depending upon the current being drawn from the unit.

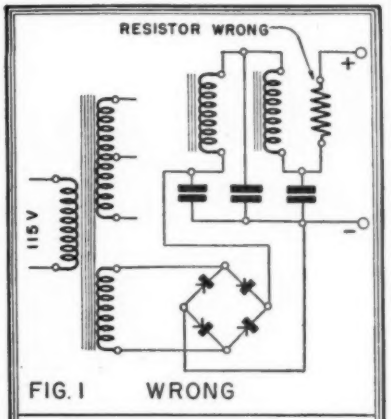
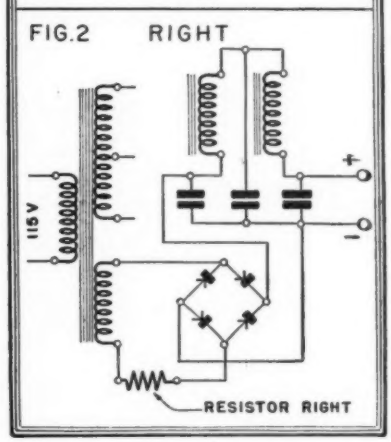


FIG. 1 WRONG

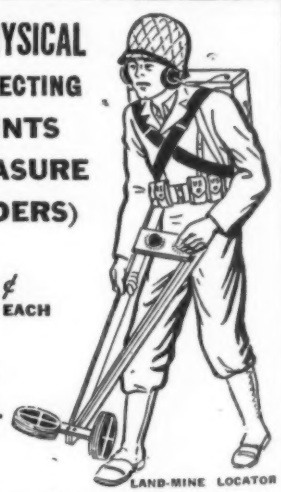


The remedy is very simple. Insert a resistor (as in Fig. 2) until with the load used, the voltage is exactly 2 or slightly less. It will be found that the voltage at the first filter condenser is between 2¾ and 3 volts using this method.

Donald Hagerman,
Belle Plaine, Minn.

GEOPHYSICAL PROSPECTING PRINTS (TREASURE FINDERS)

50¢ EACH
7 FOR $3.—



LAND-MINE LOCATOR

With any one of the modern geophysical methods described in the Blue-Print patterns, radio outfits and instruments can be constructed to locate metal and ore deposits (prospecting); finding lost or buried treasures; metal war relics; sea and land mines and "duds"; mineral deposits; subterranean water veins; oil deposits (under certain circumstances); buried gas and water pipes; tools or other metallic objects sunken in water, etc., etc.

Folder No. 1. Radiodetector Pilot. Construction and use of 2 tube transmitter and 3 tube receiver. Reflected wave principle. Visual and aural signals.
Folder No. 2. Harmonic Frequency Locator. Radiates low frequency wave to receiver. Aural signals.
Folder No. 3. Beat Note Indicator. 2 oscillators. Visual and aural signals.
Folder No. 4. Radio Balance Surveyor. Balanced loop principle. Modulated transmitter. Visual and aural signals.
Folder No. 5. Variable Inductance Monitor. Inductance principle Aural signals.
Folder No. 6. Hughes Inductance Balance Explorer. Bridge principle. Aural signals.
Folder No. 7. Radiodyne Prospector. Balanced loop principle. Very large field of penetration. Aural signals.

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RC-8-44

Reports of old sets which sold for $30.00 in 1933 being dusted off and sold from $45.00 up are coming from some points. The record is held, however, by a midget which was recently auctioned off in England at a sailors' benefit. The radio, an Emerson "Personal" Model 432, sold at £450 ($1800 approximately). This, the Emerson people believe, constitutes an all-time record for a radio which sold in this country for $24.95 before the war.

●

Regulations regarding announcement of transcribed matter in broadcasts have been relaxed by the FCC. Ordinarily programs require only one announcement per hour, stating which parts of the program during the past hour were transcribed. Recorded programs of speeches, news events or other programs in which the element of time is of special significance must be announced as recorded both before and after the broadcast of the recorded item, to avoid possibly giving the audience the impression that the event is occurring simultaneously with the broadcast.

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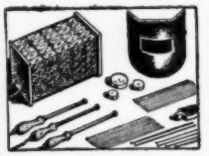
THE MAGIC ELECTRIC WELDER



Here is one of the most compact, practical welders we have ever seen. Anyone can use it for shop, farm and home repairs. WELDS, BRAZES, SOLDERS, CUTS ALL METALS. ANYONE CAN OPERATE IT. Repairs steel, cast iron, aluminum, brass, copper, bronze, etc. Complete with power unit, flame and metallic arc attachments. (Really two welders in one). Carbons, fluxes, rods, mask included. Just plug it in any electric outlet. 110 volts AC or DC. For hobbyist or professional.

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YOUR PRICE **$19.95**

WESTERN ELECTRIC BREAST MIKE

This is a fine light-weight aircraft carbon microphone. It weighs only 1 lb.

Mike comes with breastplate mounting and has 2-way swiveling adjustment so that it can be adjusted to any desired position. There are 2 woven straps; one goes around neck, the other around chest. Straps can be snapped on and off quickly by an ingenious arrangement.

This excellent mike can be adapted for home broadcasting or private communication systems. By dismounting breastplate, it can be used as desk mike.

Comes complete with 6-foot cord and hard rubber plug. Finished in sherardized plate, non-rustable.

THIS IS A BRAND NEW MIKE. IT HAS NEVER BEEN SOLD AT SUCH A LOW PRICE BEFORE. ORIGINAL LIST PRICE $15.00. Shipping weight, 2 lbs.

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POWERFUL ALL-PURPOSE INDUCTION MOTOR

IDEAL FOR EXPERIMENTERS—101 USES

Sturdily constructed to precision standards, this self-starting shaded pole A.C. induction motor is powerful enough for a number of uses. Some of these are: Automatic Timing Devices, Current Interrupters, Electric Fans, Electric Chimes, Window Displays, Photocell Control Devices, Electric Vibrators, Small Grinders, Buffers and Polishers, Miniature Pumps, Mechanical Models, Sirens, and other applications.

Consumes about 15 watts of power and has a speed of 3,000 r.p.m. When geared down, this sturdy unit will constantly operate an 18-inch turntable loaded with 200 lbs. dead weight—THAT'S POWER!

Dimensions 3" high by 2" wide by 1¾" deep; has 4 convenient mounting studs; shaft is ⅞" long by 3/16" diameter, and runs in self-aligning oil-retaining bearings. Designed for 110-20 volts, 50-60 cycles, A.C. only. Shp. Wt. 1 lb.

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Name .....

Address .....
Please Print Clearly

City ..... State .....

Send remittance by check, stamps or money order; register letter if you send cash or stamps.

The Mail Bag

A TREASURE LOCATOR FROM CANADA

Radio-Craft has had some correspondence with Mr. K. B. Thomas of Toronto, Canada, who has used metal locators both for searching out bodies of pure metal such as gas and water pipes, and for locating ores. Asked about the behavior of metal locators in the presence of ores with a low concentration of metal, Mr. Thomas replied with the following very interesting letter.

Dear Editor:

Regarding the reaction given by a radio balance machine on ores, I find in most cases it is quite distinguishable due to the fact that the ore itself would be of a different composition than the country rock. Even if there is only a small amount of metal therein, it is a better conductor, causing a deflection in the needle, at which time I examine the formation more closely.

Large masses of metallic ores give a more distinct indication on the machine and this applies to ores at considerable depth. Ores containing only a small amount of metal cannot be picked up at depth.

I read your magazine in the hope that someone will build a more compact and more sensitive instrument than the radio balance machine. I feel that I speak from experience as I have used these machines since 1938. They are very heavy and very cumbersome for bush work and in many cases it is impossible to use the machine except where we have first gone by foot and where the formation looks promising or samples prove up. A trail is then cut, cross cutting the formation. In cases where an out-cropping has been found and the area is staked the machine is very good to trace the vein where it runs into a swamp, etc. But I am sure you agree with me that a machine is required that is sensitive, light in weight and which will, if possible, give the direction in which mineral may be located. The same thing applies to "Buried Treasure." With the radio balance machine it is necessary to clear the land of brush and cover the area by traversing back and forth for a distance of the width of the machine each time. A distance of six feet could be allowed if one definitely knew how deep the treasure was buried as I find an isolated object will react on the machine three feet before getting over it, providing it is five or six feet deep. If the same body (unless an extra large one such as a chest of specie or bullion) was only one foot below ground, it would be necessary to get directly over it.

Mr. Thomas with his treasure and ore locator.

It would be a wonderful discovery if one of your readers could devise a means of measuring the wave length of each mineral, etc., and be able to locate minerals by this method. I speak as a prospector and regret I am not able to delve into Electronics.

K. B. THOMAS,
Toronto, Canada.

THIRTY-FIVE YEARS LATE

Dear Editor:

This letter should have been written to you some thirty-five years ago. That monster, Procrastination, has month after month, for all these years, truly been the "thief of time."

As a youth in the first year at the Atlantic City High School, I purchased my first copy of MODERN ELECTRICS. This magazine opened my eyes to the mysteries of science, the basic principles of which I was soon to study in school.

Despite the apparent completeness of the study courses in the various schools in which I have studied, I have always looked forward with eagerness for your publication.

My father appreciated my ambitions along the lines of radio and purchased from the Clapp-Eastman Co. a transmitting and receiving set. This was in 1908, if memory serves me correctly. Soon after that, the *Republic* sank off the Florida coast, and I heard Jack Binn's frantic call, "C . . . Q . . — . D — . ." as it came along the shores of the "mournful and mystic Atlantic."

I became a member of the Wireless Association of America, and later the Radio League of America. I cherished above everything my button with the blue field and tower. Recently someone loved it more, and relieved me of it.

Time now finds me a naval electrician, having served in the New York and the Washington Navy Yards. The way up has been a hard one; for if one would wrestle from nature her secrets, he must of necessity work "with a borrowed strength from all past ages." And it is so true that today I am strong in the electrical field because I have read Gernsback.

In closing, may I take the liberty of commenting on your timely editorial, "The Nazis Are First." This article is another of your topical and traditional truths.

LAWRENCE HARTGROVE.
Washington, D. C.

MORE ON THE RADIUM RADIO RECEIVER

Radio-Craft Magazine
Electronification Dept.:

I'm too busy to compliment editors, etc., on articles written in magazines—but Prof. M. U. Fips did it!

I seriously read *Radio-Craft* as a hobby and dream over the articles and diagrams. However, your radium article, from my point of view, was excruciatingly humorous.

I hope you publish more of those "serious" letters you received. Everything about the article, letters received, the follow-up, "That Radium Radio"—everything—was written in masterful style. It is a radionic literary gem—it is a classic in electronic humor.

Thanks for giving me many a laugh.

D. B. FOGEL,
Kansas City, Mo.

P. S. Just told the clerks at Burstein-Applebee (whom I see at lunch every day) that there is a radium device which will put them out of business. They are now rushing around trying to find the article. —*D. B. F.*

OPPOSES LICENSING OF SERVICEMEN

Dear Editor:

Your "Mail Bag" section is one of the very first sections I read when I get your magazine. Fine business, keep up the good work. Only I did get burned up on this "Licensing the Service Man" gag. Maybe the idea is okay, but it won't work.

Why pick on the experimenter, beginner, ham or "screw-driver mechanic" who has enough ambition to help himself. Don't worry if his work is no good—he won't last long. He'll cut his own throat.* If he does tangle up a customer's radio, the customer will then bring it to you to straighten out, then you can really pour on the repair charges with a good excuse.

Maybe it's because these so-called "super-duper" service men are afraid that somebody will take away some of their business, but I have found radio repair is the same as any other business. If you please your customer and treat him the way you yourself would like to be treated, you wouldn't need a license to protect you. You fellows who are doing all the yapping about the "license" aren't worrying about your customers; you are worrying about the almighty dollar that lines your pocket.

How many of you "Hot shot" stool warmers, after making a "V" repair on a radio, such as a tube substitution or change in the circuit, leave a diagram of the "headaches" you have caused for some future service man, to put back so it will conform with the manufacturer's original diagram? Oh, no! That would take too much time. What do you care? Chances are you won't have to repair it again for the next two or three years. By that time you can rest on your laurels and say we "Kept them playing" (or did you say "paying").

CARL L. HOBAN,
Streator, Ill.

(*What Mr. Hoban fails to understand is that the screw-driver expert tends to cut the throat of several other people while in the process of cutting his own. The radio set owner cannot see why John Radioman should charge $3.00 for a job which takes less than an hour, when Bill Tinker was willing to work over the same set for three hours at a charge of 50c. The depression of price standards and destruction of confidence in radio repairmen caused by Bill Tinker is unfortunately not confined to Bill himself. All radiomen in the district bear a share of it.—*Editor*)

SERVICING—PROFESSION OR HOBBY?

Dear Editor:

Imagine a conversation like the following: Ailing Customer (to Specialist)—"Please look me over and tell me why I am sick. I can't afford your regular fee for treatment, but I know where I can get a very nice young physiology student to fix me up when I tell him what is wrong." Ridiculous? Yes, very much so!

But are we not opposing the young medical student's "rights of personal liberty, contractual engagement and free enterprise" when we lawfully suppress his right to "practice"?

As for "prohibitive costs," no one has suggested "holding up" the bona fide amateur or ham operator—but please, gentlemen, give the professionals a chance to earn our bread and butter with a clear conscience—not feel like Black Market Operators when we ask a fair mark-up on our cost for the parts we sell. Our equipment costs money, so does our store and shop, our telephone and our "service wagon" if we are lucky enough to have one.

License examinations? Of course. You call this a profession, Mr. Thompson. So do we. And no real professional should fear such a test of his ability to give the radio public a square deal at a fair competitive price—and so be protected from the antics of the so-called "screw-driver mechanics." Amateur tinkering electricians, plumbers, builders, etc., are discouraged until they learn the game.

DAVID BROOKS,
Oakland, California.

MORE SCHEMATICS AND DETAILS NEEDED?

Dear Editor:

As a Radio experimenter, designer, constructor and one interested in all its branches, such as P.A., Receivers, Television, Test Apparatus, Hearing Aids, Sound Producing Instruments, Recording Methods, etc., and as a subscriber to *Radio-Craft* since its inception, I feel that I'm in a position to advise just what your readers (as a whole) are interested in. That is more schematics and detailed information (intelligible to the novice and "graduate") on the above subjects, including Radiology, Thermopathy, etc. Particularly the inside dope on latest apparatus, such as the new hearing aids.

WILLIAM M. FURY,
Philadelphia, Pa.

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MOBILE RADIO STATION

(Continued from page 658)

dard receivers, the Signal Corps BC-312 and BC-342, and a speech amplifier.

Two field telephones with a mile of wire are also included, so the truck can become part of a liason network with wire and radio communication, using only its own apparatus. The truck provides space for accessories not easily carried with more compact rigs, so we find a complete set of tools and spare parts and a Signal Corps frequency meter as permanent equipment.

The range of the 450-watt transmitter is said to be over 100 miles in daylight, using either voice or code, and travelling at full speed. A special type of antenna transformer was required to match the output of the transmitter to the 15-foot whip antenna used in the truck, and range is, of course, somewhat reduced by this limited radiation system. Where the set can be used in a permanent or semi-permanent position, a more suitable aerial is erected, and the range is greatly extended.

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INDUCTANCE METER

(Continued from page 665)

higher multiplying ranges when we switch in the 400 and 200 MMF condensers. Scale D takes care of this change.

The oscillator coils are preferably permeability tuned and may be shunted by a very small trimmer to equalize the possible small change of capacitance when switching from one coil to another. At point "1" the trimmer is adjusted for proper frequency (in table) and at point "5" the inductance is adjusted.

Range (μH)	Scale C switch position	Oscillator Inductance (μH)	Frequency (Mcs) at scale A position: 1	5
1 to	A x 1	0.4	35.6	15.9
10	B x 1	2.0	15.9	7.12
10 to	A x 10	4.0	11.25	5.03
100	B x 10	20.0	5.03	2.25
100 to	A x 100	400.0	1.125	0.503
1000	B x 100	2000.0	0.503	0.225

Fig. 5—Calibration table for the oscillator.

To make a measurement, the unknown coil is placed across the "test" terminals. Switch "D" is set to position 1 on the proper scale depending upon estimated inductance of the unknown. Scale C dial is now left at A x 1 and the oscillator dial rotated throughout its range. We do the same at B x 1 and so on until resonance is indicated on the VTVM. The condenser reading is noted. If scale C indicates B x 10, for instance, and we find B points to 15.6, we would note 156. Now scale D switch is set at 2 and again we find resonance. This time, say we obtain maximum when scale D is on A x 10 and A points to 2.3 units. The unknown has an inductance of 156—23 or 133 microhenries. As the resonant point is approached, sensitivity may be reduced, by varying the resistor in the VTVM cathode circuit.

L (μH)	No. Turns	Coil Diam.	Coil Length
.4	4¾	1"	1"
2	11	1"	1"
4	11	1½"	1"
20	23	1½"	1"
400	130	2"	2½"
2000	260	2"	2½"

COIL DATA—Fig. 6

The self-capacitance of the coil which is necessary information when designing a circuit to cover a definite tuning range is found as follows: Recalling the two earlier formulae $L(C_1 + C_0) = L_2X$ and $L(C_2 + C_0) = L_2Y$ we may divide to obtain

$$\frac{C_1 + C_0}{C_2 + C_0} = \frac{X}{Y}.$$

Simplifying, $C_1Y + C_0Y = XC_2 + XC_0$ or

$$C_0 = \frac{XC_2 - YC_1}{Y - X}$$

which becomes

$$C_0 = \frac{C_2(2Y - X)}{(X - Y)}.$$

This can be easily calculated when C_2 and the two condenser readings X and Y are known. The value of C_2 depends upon scale D setting.

A 6J7 may be used for the oscillator and vacuum-tube voltmeter tubes, with one section of a 6H6 for the diode. The plate requirements are small so that any convenient power rectifier may be used. Coil data is given in Fig. 6. As an alternative to permeability-tuned coils the smaller coils may be self-supporting, being wound with heavy wire, while the very large coils may be wound with fine wire such that each coil length requirement may be met.

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(While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.)

BOOK REVIEWS

SHORT WAVE WIRELESS COMMUNICATION, by A. W. Ladner and C. R. Stoner. Published by John Wiley & Sons, Inc. Stiff cloth covers, 6 x 8½ inches, 573 pages. Price $6.00.

This is the fourth edition of this standard work by two leading British workers in the short-wave and ultra-short-wave field. Chapters have been grouped in more logical order, and material on ultra-short-wave technique has been spread throughout the book instead of being dealt with in one chapter. The increasing importance of ultra-short-waves is the logical reason for this. New material and new illustrations have been added.

Short-wave communication is not treated to the exception of everything else—there are two chapters on modulation, one dealing with theory and one with practical circuits. Suppressed carrier and single sideband are discussed as well as ordinary AM and FM. The chapter on aerials begins with long-wave theory before proceeding to short waves.

Propagation of short and ultra-short waves is handled in two chapters, the first on transmission over short distances and the second covering propagation over ionospheric paths. These two chapters are followed by one on high-frequency feeders, which introduces two chapters on antennas. The first of these discusses simple aerials and the second, aerial arrays.

A very interesting chapter is devoted to commercial wireless telephone circuits, in which carrier, suppressed carrier, expander-compressor and speech inversion systems are discussed, as well as diversity reception. The commercial angle is to be seen in other parts of the book, and there are a number of excellent schematics of commercial apparatus not found in many radio texts.

RADIO DIRECTION FINDERS, by Donald S. Bond. Published by the McGraw-Hill Book Co. Stiff cloth covers, 5½ x 8½ inches, 287 pages. Price $3.00.

Written primarily for the trained radio engineer, either for the theory of direction-finding apparatus, or as a reference in designing such equipment, this book presents a complete analysis of the operation of loop-type and horizontal-wave (Adcock) direction finders. The author suggests that, should the reader have more limited technical training, he will be aided by the detailed mathematical derivations in the footnotes and the Appendix.

The problem is first approached in the field of theory, wave propagation and directive antenna systems being considered in two long chapters. Aural-null direction finders are then discussed, and a short chapter is given over to the performance characteristics of loop input circuits.

The longest chapter in the book deals with visual direction finders, a subject on which information is especially valuable at this time. The principles on which devices may be operated is discussed, and two standard automatic direction finders, the RCA-Sperry Mark I and the Bendix MN-31 are described fully. Schematics of both are provided in long inserts.

A bibliography is given at the end of each chapter and an index by subjects and names is provided.

RADIO RESEARCH, edited by Paul F. Lazarsfeld and Frank Stanton. Published by Duell, Sloan and Pearce. Stiff cloth covers, 6 x 8½ inches, 599 pages. Price $5.00.

The average reader may be accustomed to thinking of radio research as purely an investigation of "who listens when, and to what." Such purely quantitative data plays a small part in this book—it is chiefly occupied with qualitative studies. Several techniques are presented, and the material proves the value of this type of research both in widening program coverage and improving individual broadcasts.

A large part of the book is devoted to "listening to the listener." Part III of the book is entirely given over to experiences with the Program Analyzer, a device with which the listener makes his likes and dislikes known by pushing a green or red button. The Analyzer records the reactions. Strong or weak points in a broadcast are thus brought to light. Script writers find this important. One example is given of a program being so rewritten as to practically double its audience appeal, after a preliminary analysis showed up its weaknesses. Other discoveries made by the Analyzer are valuable to program directors and sponsors. The outstanding example is its unmistakable indication that "a good program makes a good commercial." The Analyzer proved that the majority of listeners who like a given program rate the blurb which follows "good," but that only a small minority who did not care for the program look with favor on the closing commercial.

The editors are well equipped for their work. Professor Lazarsfeld is Director of the Office of Radio Research, Columbia University. Dr. Stanton is Vice-President of the Columbia Broadcasting System. Many of the contributors are also authoritative writers in their own fields of radio research.

SHOP JOB SHEETS IN RADIO, by Robert Neil Auble. Published by the MacMillan Co. Flexible fiber cover with board back, 8 x 11 inches, 134 pages. Price $1.50.

Although this is to all appearances a laboratory manual, the author is insistent that it is not a book of experiments. Every effort, he says, has been made to eliminate the idea of "experiment" and instead, "to give emphasis to the need of the beginner to have *experience* in the use of tools of the radio worker, and to have that experienced based upon an organized knowledge of fundamental electrical principles."

It is further suggested that the book should be used in conjunction with a well-equipped shop, under the direction of instructors with a rich background of practical radio experience, and that the shop work be paralleled with systematic classroom discussion.

The jobs run from making electrical connections and wiring up the simplest piece of apparatus to determining capacity of condensers, constructing an ohmmeter, and analyzing the action of a rectifier tube with the help of a cathode-ray oscilloscope.

In two jobs (measuring magnetic saturation and the resistance variation of a volume control as the knob is turned), a page of graph paper is provided and the student is required to make his own graphs. Ruled tables are also supplied for the student to fill in. In at least one case these follow the tradition of the old laboratory manual rather than the "shop job sheet." No shop worker would write down the steps in checking an audio transformer's continuity.

The jobs are intelligently worked up and clearly explained and illustrated. References to standard texts are given in most of the "jobs." A group of "topics for classroom discussion" is included with each. These topics should be of great use to the teacher, covering as they do a much wider field than that of the immediate job.

Suggested by: Tom Jewett, Clyde, Ohio

". . . and every time a blonde goes by, it whistles! See!!"

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This relay was made from an old Baldwin balanced armature speaker unit. The spring D of Fig. 1 is a piece of old alarm-clock mainspring, which must be stiff enough so that the magnet will not pull it to either pole. It must be mounted so that normally it is centered between them. Spring and coil are held by the brass supports B bent as shown in the figure. The spring D is insulated from the rest of the assembly by the insulating washers i, i, and also by a small fiber tube which extends through the spring and both washers as shown in Fig. 1.

The contacts E are provided by soldering small pieces of silver to each side of spring D, and to the ends of the contact screws that go through the binding posts P1 and P2 (in Fig. 3).

The coil form is made by cutting out two end plates from heavy fiber. The shape is shown in Fig. 2. The exact size is determined by the space allowed by the magnet, and the notches O. O., should be carefully cut so the coil will be held firmly in position. Next a flat strip is cut for the center piece. The spring may be built up by wrapping it with heavy paper and this center piece formed around it. There must be sufficient space for movement of the spring, but no more, if the unit is to be sensitive. The ends of the strip should be butted together along the side, not the edge, of the spring, and form a smooth joint. The two end pieces are then slipped over the ends of this center piece and securely cemented in place.

The entire secondary winding of an old audio transformer was used to wind the coil. The resistance was approximately 6,000 ohms. Light stranded wire should be used for leads and anchored to the body of the coil.

The panel of Fig. 3 is a 3-inch square piece of bakelite with a hole cut through for the spring D. The fixed contacts P1 and P2 are two double binding posts with one hole in each tapped for a 6-32 screw. The set screw is used as a lock. Two of the single posts M1, M2 and M3 are used for coil terminals, the third being connected to the spring by an insulated wire soldered to it at the rigid end.

The relay is best assembled piece by piece, then the whole thing can be arranged and adjusted, making sure that the spring is able to move freely.

This is an extremely sensitive relay. While the Baldwin phone unit is best adapted for it, no doubt an excellent relay along the same lines could be made from any balanced-armature unit from a magnetic speaker.

ARCHIE V. CARPENTER
Rewey, Wisconsin

(Lack of space prevented printing this item with the relays described last month. It won an "honorable mention" in the contest.—Editor)

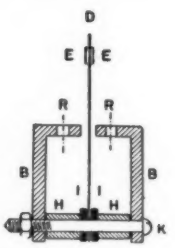

FIG. 1

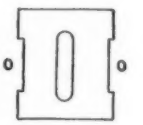

FIG. 2

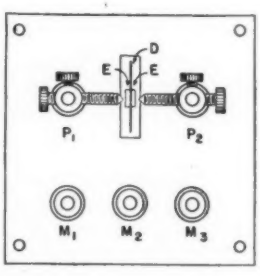

FIG. 3

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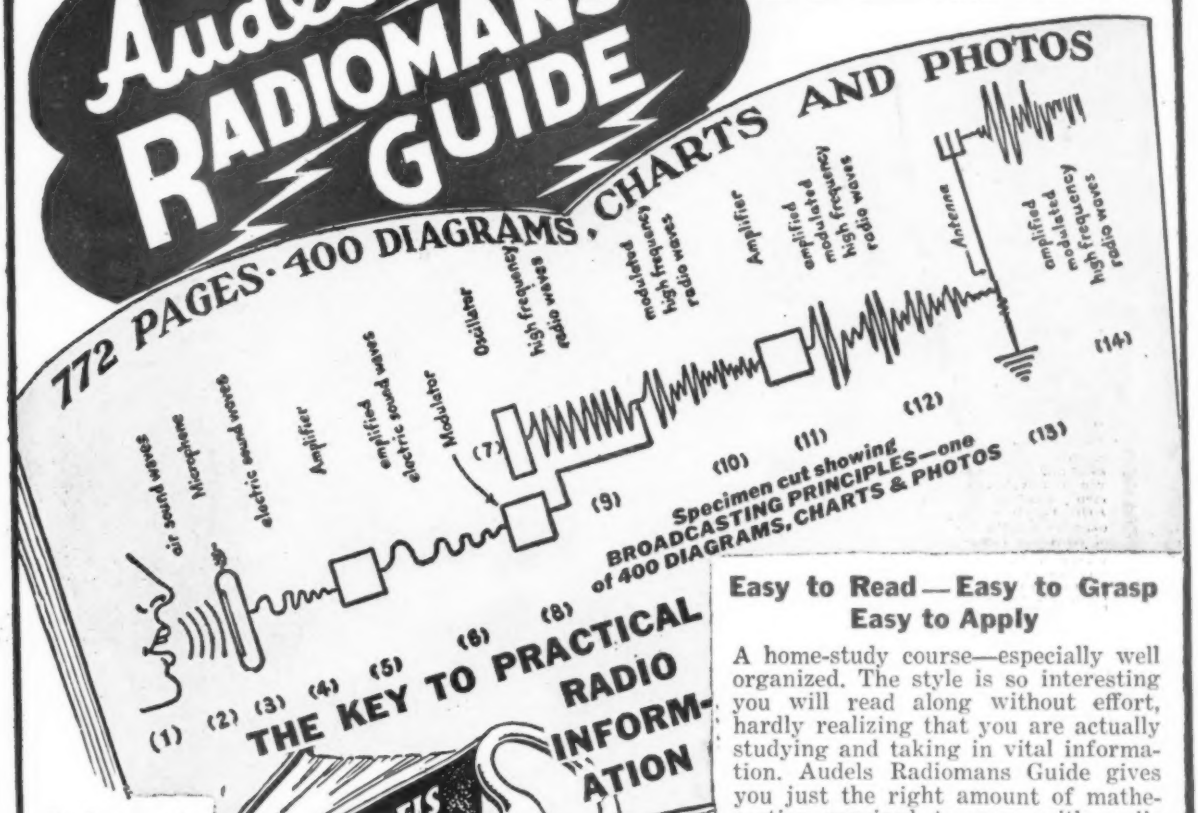
air sound waves
Microphone
electric sound waves
Amplifier
amplified electric sound waves
Modulator
Oscillator
high frequency radio waves
modulated high frequency radio waves
Amplifier
amplified modulated high frequency radio waves
Antenna
amplified modulated high frequency radio waves
(1) (2) (3) (4) (5) (6) (7) (8) (9) (10) (11) (12) (13) (14)
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by don herold

We hear an awful lot about the wonderful new products that will appear after the war.

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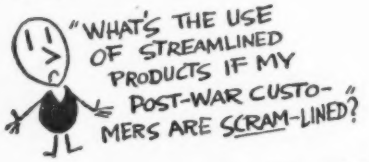
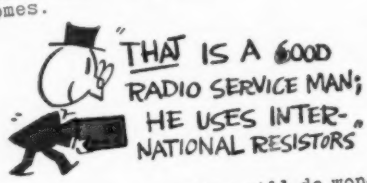
But a lot of factories and dealers are forgetting that customers, as well as products, have to be "planned."

We don't hear enough about post-war customer designing.



Right now is the time for every radio service man to be "engineering" and blue-printing a nice batch of friendly, receptive, prospective customers for the days to come.

Furthermore, every service man should be doing a whale of a lot of cogitatin' about the post-war products and services he'll be offering to the folks he's warming up now. He'll still be doctoring radios, and maybe he'll also want to sell them their new post-war radios...that is just good business. And maybe, too, he'll decide to pick up a lot of extra folding money by repairing other electrical equipment in their homes.



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